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Rio Blanco Oil Shale Project

PROGRESS REPORT 6 - SUMMARY

December, 1975 · January · February, 1976

Gulf Oil Corporation
and
Standard Oil Company (Indiana)
9725 East Hampden Avenue, Denver, Colorado 80231

RIO BLANCO OIL SHALE PROJECT

DAYTON COMMONS 9725 E. HAMPDEN AVENUE
DENVER, COLORADO 80231 303-751-2030

GULF OIL CORPORATION - STANDARD OIL COMPANY

April 30, 1976

Mr. Peter A. Rutledge
Area Oil Shale Supervisor
USDI - Geological Survey
Mesa Federal Savings & Loan
131 N. 6th - Suite 300
Grand Junction, Colorado 81501

Dear Mr. Rutledge:

Please be advised that the values for hydrocarbons, carbon monoxide, and nitrogen oxide concentrations being presented in Progress Report 6 and Progress Report 6-Summary are substantially higher than those previously reported for the Spring through Fall 1975 quarters. An internal quality assurance audit has revealed that a systematic but incorrect conversion had been applied to non-zero calibration gases in the period indicated.

The above concentrations are being revised by multiplying each value by 1.3 for the identified substances and time frames as follows:

For Total Hydrocarbons, Methane and Non-methane Hydrocarbon, all values from 14 April 1975 at Site 1 and 23 April 1975 at Sites 2, 3 and 4 through 30 November 1975;

For Nitric Oxide, Total Oxides of Nitrogen and Nitrogen Dioxide, all values from 15 May 1975 at Site 1 and 16 May 1975 at Site 3 through 30 November 1975;

For Carbon Monoxide all values from 20 April 1975 at Sites 1 and 3 through 30 November 1975.

Revised data and text for Progress Reports 3, 4 and 5 are being developed and will be submitted to your office. Agencies making use of this information should be advised to contact your office for corrected data.

United States Department of the Interior

GEOLOGICAL SURVEY
Conservation Division
Area Oil Shale Supervisor
Suite 300,Mesa Federal Savings Bldg.
131 N. 6th Street
Grand Junction, Colo. 81501

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May 20, 1976

The attached report is the sixth of a planned series of reports from the Federal Oil Shale Lessees to the Area Oil Shale Supervisor describing progress under approved exploration and baseline data plans.

The purpose of these reports is to provide interested parties with a review of ongoing operations and a summary of the data being collected. Because of the sheer volume of data being generated, these reports should be considered as the first (overview) phase of planned data distribution. Parties interested in reviewing more detailed data on specific portions of the program should contact the Area Oil Shale Office in Grand Junction where such data will be kept on file.

We would appreciate receiving any comments or suggestions you may have concerning these reports.

PETER A. RUTLEDGE
AREA OIL SHALE SUPERVISOR

This correction factor must also be applied to data summaries used in the DDP. Revised tables, figures and text will be supplied to you in the near future. Application of the above multiplication factor will not affect any of the conclusions reached in the air quality modeling and evaluation section of the DDP (Section 9, Chapter 5).

Very truly yours,

Walter T. Herget
President

WTH:pr

PROGRESS REPORT 6 - SUMMARY

TRACT C-a OIL SHALE DEVELOPMENT

to

AREA OIL SHALE SUPERVISOR
UNITED STATES GEOLOGICAL SURVEY

April 30, 1976

by

RIO BLANCO OIL SHALE PROJECT

Gulf Oil Corporation
and
Standard Oil Company (Indiana)

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INTRODUCTION

Rio Blanco Oil Shale Project (Gulf Oil Corporation and Standard Oil Company of Indiana), hereafter referred to in this report as RBOSP, is presenting it's sixth summary progress report for Tract C-a to the USGS Area Oil Shale Supervisor (AOSS). This report is a summary of work accomplished during the period December 1, 1975 through February 29, 1976. The baseline data gathered for the project are on file in the Area Oil Shale Supervisor's Office in Grand Junction, Colorado. These data and its interpretive text comprise Progress Report 6. This summary report presents an overview and highlights of these data and has been correlated to and organized consistent with Progress Report 6; that is, the numbering system and topic headings for the summary report is the same as that used in the Progress Report. For more detailed information the reader should refer to the Progress Report.

As has been done for Progress Reports 2 through 5, the numbering system for this report is consistent with those of the previous reports. Therefore, a reader desiring information on the same subject in the previous reports (both Summary and Progress Reports) will find it under the same title heading and number. For the Geotechnical section, only those tasks are included for which activity was reported for the quarter. For the environmental section, if information concerning objectives and methodology has not changed, the reader is referred to the appropriate report where these topics are discussed.

It should be noted that results of data taken during this quarterly reporting period but not available in time for this progress report will be included in the ensuing reports.

Additional information for the subjects covered in this progress report can be found in the following:

- Tract C-a Detailed Development Plan - March 1976
- Previous Progress Reports on file with the AOSS
- Annual Report - Tract C-a - Terrestrial Ecology Baseline Studies - March, 1976
- Annual Report - Tract C-a - Aquatic Ecology Baseline Studies -March 1976

For general informational purposes in this report, two figures are shown. Figure 1 is a location map of Tract C-a showing major drainages, roads, towns and counties in the vicinity of the tract. Figure 2 shows Tract C-a in greater detail and generally locates the drill holes, stream gaging stations, air quality towers and roads.

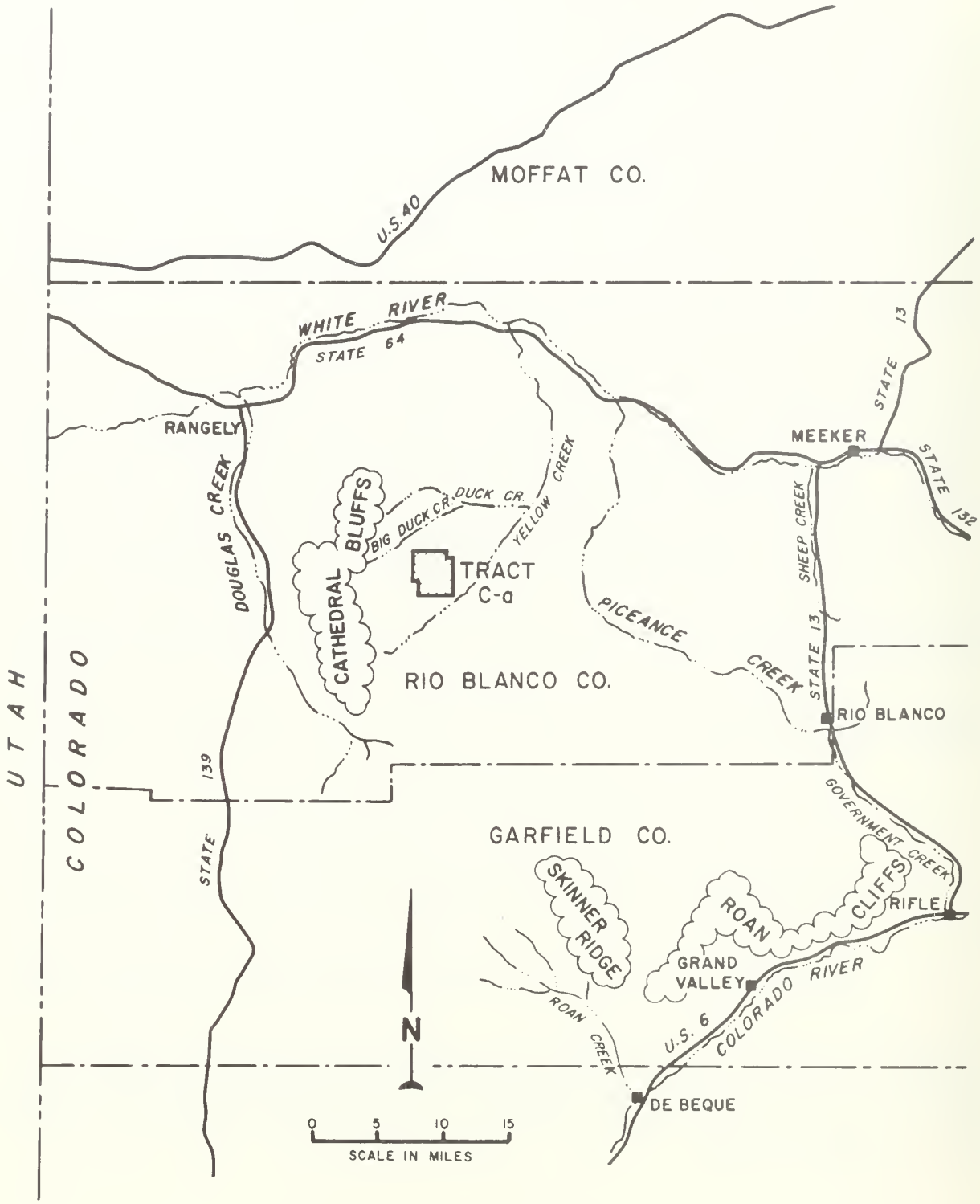
MOFFAT CO.
U.S. 40
WHITE RIVER
STATE 64
RANGELY
DOUGLAS CREEK
CATHEDRAL BLUFFS
BIG DUCK CR.
DUCK CR.
YELLOW CREEK
TRACT C-a
PICEANCE CREEK
SHEEP CREEK
MEEKER
STATE 13
STATE 132
RIO BLANCO CO.
RIO BLANCO
STATE 139
GARFIELD CO.
GOVERNMENT CREEK
SKINNER RIDGE
ROAN CLIFFS
RIFLE
GRAND VALLEY
ROAN CREEK
U.S. 6
COLORADO RIVER
DE BEQUE
UTAH
COLORADO
N
0 5 10 15
SCALE IN MILES

Figure 1

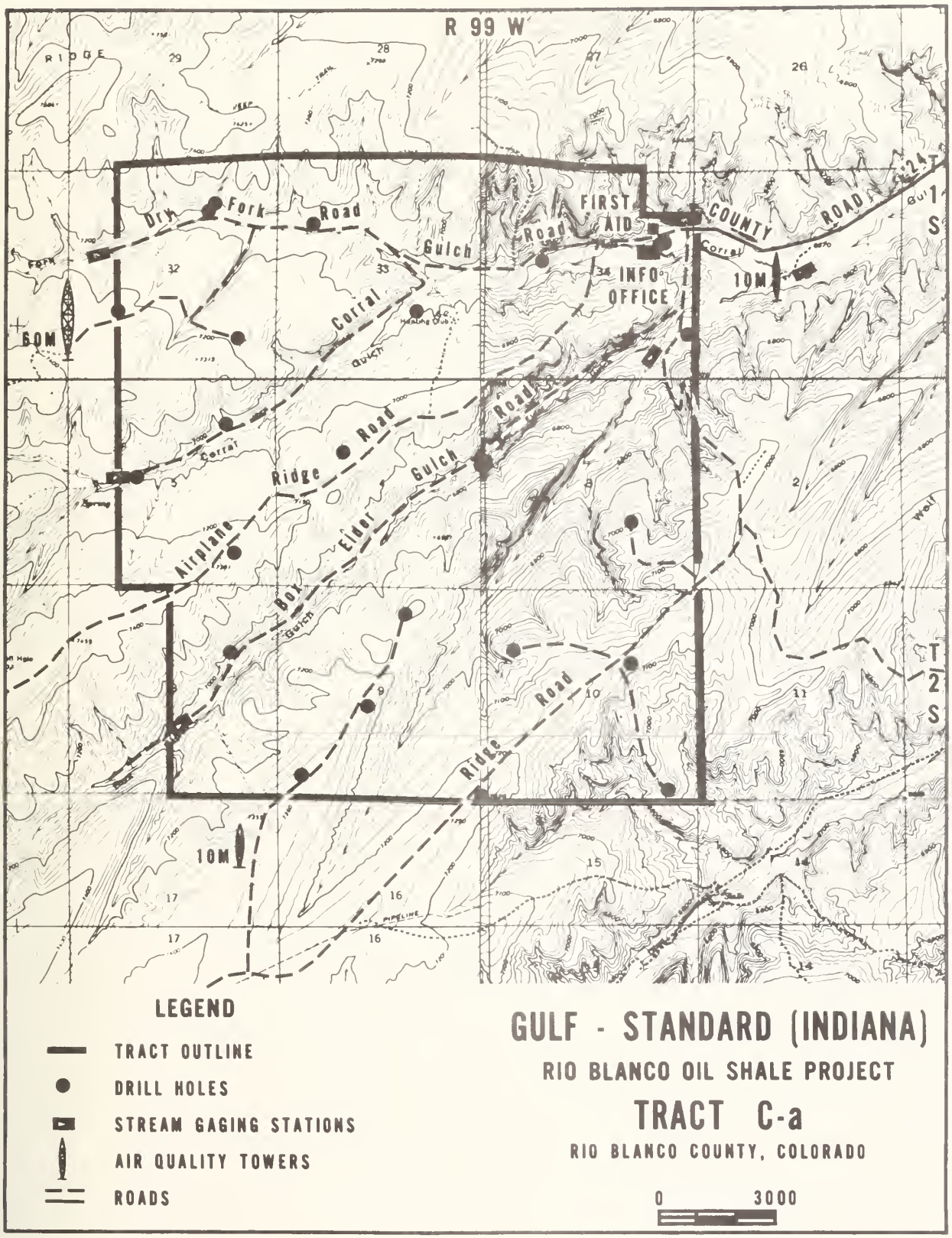
R 99 W
RIDGE
Dry Fork
Road
Gulch
FIRST AID
COUNTY ROAD
INFO OFFICE
60M
10M
Corral
Ridge Road
Airplane
Box Elder Gulch
Road
Ridge
T 12 S
T 1 S
LEGEND
TRACT OUTLINE
DRILL HOLES
STREAM GAGING STATIONS
AIR QUALITY TOWERS
ROADS
GULF - STANDARD (INDIANA)
RIO BLANCO OIL SHALE PROJECT
TRACT C-a
RIO BLANCO COUNTY, COLORADO
0
3000

Figure 2

ABSTRACT

The Geotechnical Data Gathering Project initiated by RBOSP on Tract C-a in the spring and summer of 1974 provides data required for engineering studies as well as data necessary to establish baseline conditions. The data gathering consisted of specific tasks conducted under the geologic program and the hydrologic program. Previous RBOSP progress reports were organized to allow reporting of the ongoing activities of each task. Presently most of the major tasks under both the geologic and the hydrologic programs have been completed and consequently, the organization of the geotechnical data gathering portion of the Progress Reports has been restructured to include only those tasks in which activity was reported during the quarterly reporting period.

Activity relating to the Geologic Program during the quarterly reporting period concerned: receipt of Fischer assay results from the re-assay of coreholes G-S 4-5 and G-S 6; receipt of Fischer assay results for core samples withheld from assay in coreholes G-S 2-3, G-S 4-5, and G-S 6 from rock mechanics testing; finalizing topographic mapping on 84 Mesa north and east of Tract C-a; and the preparation of 1,116 feet of core to be split from G-S 7 core and to be analyzed by the USGS for nine specific trace elements was initiated.

Activity under the Hydrologic Program consisted of the monitoring and sampling of the various stream gaging stations and holes in and around Tract C-a. Flow was recorded at four stream gaging stations during the quarter and are listed below with the average total dissolved solids from the spontaneous sampling for the portion of the reporting period for which data were available.

Stream Gaging Station	Total Dissolved Solids (mg/l)
Corral Gulch Near West Line Tract C-a.	794
Corral Gulch East of Tract C-a	826
Corral Gulch Near 84 Ranch	1,310
Yellow Creek Near White River.	2,870

No data have yet been received for this quarterly reporting period from the three storage type rain gages. Data have been received from the three locations which have recording type gages for the month of December. The recording rain gage on Stake Springs Draw near the confluence with Corral Gulch reported a December precipitation of 0.88 inches. The recording gage on Yellow Creek near White River reported a December precipitation of 0.47 inches. The recording gage on Cathedral Bluffs recorded a December precipitation of 1.01 inches. The results for the month of December indicate that higher elevations (Cathedral Bluffs gage location) receive considerably more precipitation than lower elevations (Yellow Creek near White River gage location).

1.0 GEOTECHNICAL DATA GATHERING PROJECT

The geotechnical data gathering project initiated in the spring and summmer of 1974 has been divided into two programs -- the Geologic Program and the Hydrologic Program. Each of these programs has been subdivided into separate tasks as is shown by the work breakdown structure, Figure 1.0-1. Previous progress report summaries were organized such that the status of each of the tasks was reported whether it had been completed or not. This geotechnical data gathering portion of the progress report summary has been structured such that only the status of the tasks in which significant activity occurred during the quarterly reporting period is reported.

Table 1.0-1 is an index in which the tasks and subtasks are listed, showing the specific progress report(s) in which significant reference to any particular task was made.

Major activity during this quarterly reporting period pertaining to the Geologic Program was the receipt of the Fischer assay results from the reassay of the lower portion of coreholes G-S 4-5 and G-S 6; receipt of Fischer assay results for core samples withheld from assay in coreholes G-S 2-3, G-S 4-5, and G-S 6 for rock mechanics testing; finalizing topographic mapping on 84 Mesa located to the north and east of Tract C-a; and the initiation of the preparation of 1,116 feet of core to be split from the G-S 7 core for analysis by the USGS for a complete suite of trace elements.

The activity conducted during the quarterly reporting period under the Hydrologic Program consisted of the ongoing monitoring and sampling of the various stream gaging stations and holes in and around Tract C-a. During the second year of baseline monitoring samples will be collected: monthly for stream gages recording flow; monthly for alluvial aquifer holes during snowmelt runoff and quarterly thereafter; and semi-annually for deep aquifer monitor holes. Water level for each of the deep aquifer and alluvial aquifer monitor holes will be measured monthly.

Figure 1.0 - 1

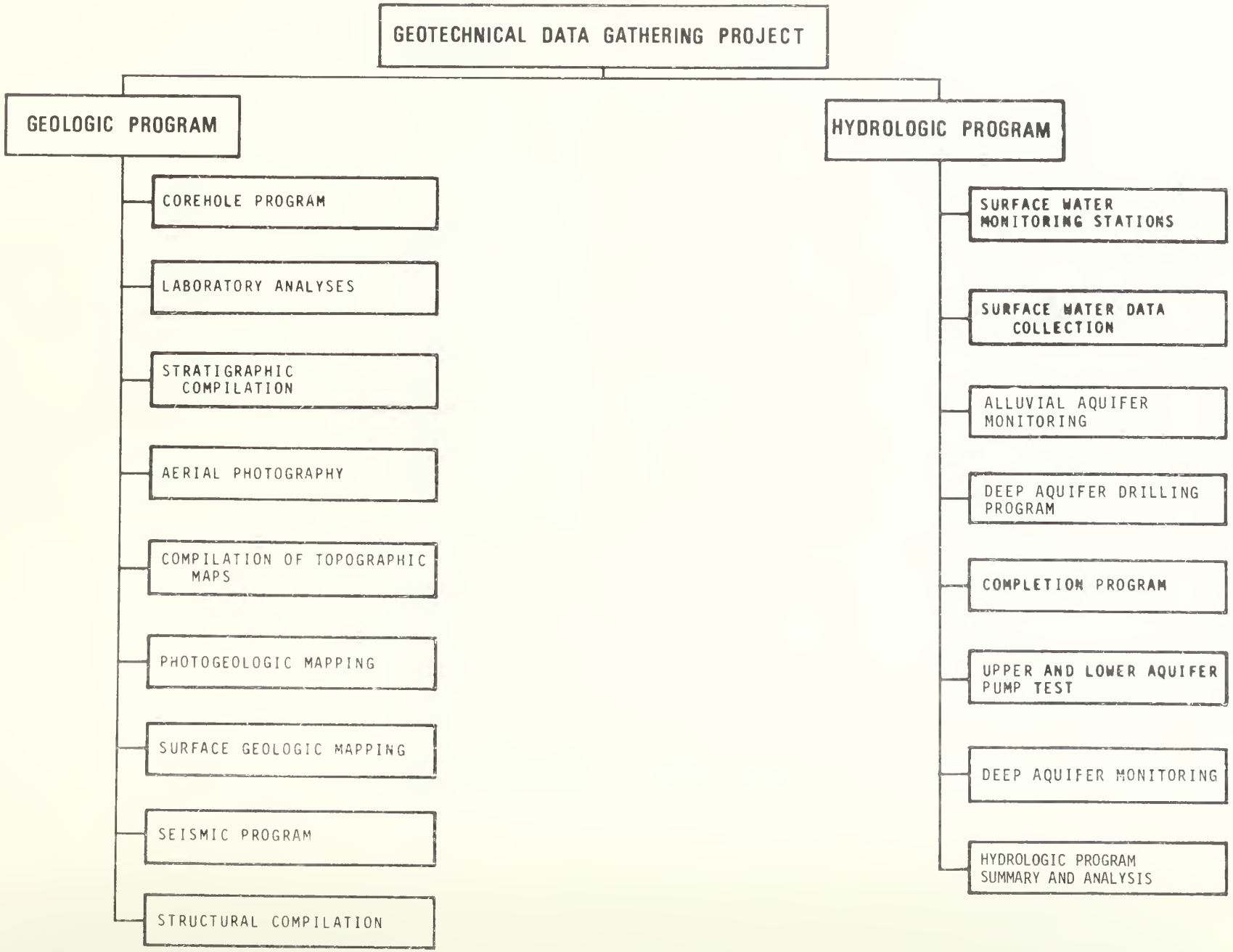
GEOTECHNICAL DATA GATHERING PROJECT
GEOLOGIC PROGRAM
COREHOLE PROGRAM
LABORATORY ANALYSES
STRATIGRAPHIC COMPILATION
AERIAL PHOTOGRAPHY
COMPILATION OF TOPOGRAPHIC MAPS
PHOTOGEOLOGIC MAPPING
SURFACE GEOLOGIC MAPPING
SEISMIC PROGRAM
STRUCTURAL COMPILATION
HYDROLOGIC PROGRAM
SURFACE WATER MONITORING STATIONS
SURFACE WATER DATA COLLECTION
ALLUVIAL AQUIFER MONITORING
DEEP AQUIFER DRILLING PROGRAM
COMPLETION PROGRAM
UPPER AND LOWER AQUIFER PUMP TEST
DEEP AQUIFER MONITORING
HYDROLOGIC PROGRAM SUMMARY AND ANALYSIS

Table 1.0-1

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1.1 Geologic Program

Activity during the quarterly reporting period included completing the re-assays of coreholes G-S 4-5 and G-S 6; completing assays of core intervals withheld for rock mechanics testing in coreholes G-S 2-3, G-S 4-5 and G-S 6; finalizing topographic mapping on 84 Mesa; and preparing samples to be analyzed for nine trace elements by the USGS. The activities are described in the following.

Oil Shale Assays

During the quarterly reporting period re-assays of core samples were completed on the lower intervals of coreholes G-S 4-5 and G-S 6. The re-assaying was begun when confirmation assaying of 45 samples from the two coreholes indicated that re-assaying was necessary. The re-assays were run on the entire interval of zones R-2 through R-5 in each of the two coreholes. The new data replaces the original assay results and will be incorporated into tract zonal grade control. The new data although significantly changing the oil shale grade average within specific zones has not greatly affected the total oil shale interval resource estimates because the changes both increased and decreased the oil shale grade and when averaged over the entire oil shale interval produced a grade average very close to the original figure. The results from the re-assays have been submitted to the Area Oil Shale Supervisor as a part of the confidential portion of RBOSP Progress Report 6.

Core intervals from the Gulf-Standard coreholes originally withheld for rock mechanics testing have been released for assaying in coreholes G-S 2-3, G-S 4-5 and G-S 6. Fischer assays have been completed on those intervals in these three coreholes. Core intervals withheld for rock mechanics testing in coreholes G-S 1, G-S 8, G-S 11, and G-S 15 have not yet been released for assay. All core in G-S 13 is being withheld from assay indefinitely for possible future tests. The Fischer assay data for the core intervals withheld from assay in coreholes G-S 2-3, G-S 4-5, and G-S 6 have been submitted to the Area Oil Shale Supervisor as a part of the confidential portion of RBOSP Progress Report 6.

Trace Element Analysis

During the quarterly reporting period, preparation of core samples to be check-analyzed for nine trace elements by the USGS was initiated. The samples will be analyzed for: antimony, arsenic, cadmium, selenium, mercury, boron, fluoride, molybdenum, and vanadium. The new trace element analysis is to be performed on 1,116 feet of core to be split from the G-S 7 core. Future progress reports will update the status of the trace element analysis by the USGS.

Compilation of Topographic Maps

Topographic mapping of about 8,200 acres encompassing the 84 Mesa which is located north and east of Tract C-a has been finalized. Copies of the finalized topographic mapping at scales of 1 inch to 500 feet and 1 inch to 200 feet have been submitted to the Area Oil Shale Supervisor under separate cover as a part of Progress Report 6.

1.2 Hydrologic Program

Rio Blanco Oil Shale Project implemented the surface and subsurface Hydrologic Program to establish baseline hydrologic conditions and to acquire data required for the design and planning of mine dewatering. The hydrologic tasks for which activity occurred during the quarterly reporting period are covered in RBOSP Progress Report 6, submitted in two parts: (1) Interpretive Text, and (2) Raw Data. Data obtained during the corehole drilling project were presented in RBOSP Progress Report 2, while data obtained during the formal pumping test were presented in RBOSP Progress Report 3. RBOSP Progress Report 4 contains hydrologic interpretive analyses. RBOSP Progress Report 5 presented annual hydrologic baseline information pertaining to surface water, alluvial aquifers, and deep aquifer monitoring. RBOSP Progress Report 6 presents updated surface water data, alluvial aquifer data and deep aquifer monitoring information. Only those tasks for which activity occurred during the quarter are reported in this progress report. The task numbering system, although not consecutive because tasks with no activity during the quarter have been omitted, is identical to previous progress reports.

1.2.1 Surface Water Monitoring Stations

RBOSP has contracted with the Colorado River Water Conservation District to have the Water Resources Division (WRD) of the United States Geological Survey (USGS) construct and operate surface water monitoring stations. RBOSP Progress Reports 2, 3, and 4 described the eleven operating stream gaging stations and six rain gaging stations.

Table 1.2-1 lists each of the eleven stream gaging stations and the six rain gaging stations, the USGS identification number, and a description of the location of each station. Figure 1.2-1 shows the location of the stream gaging stations and the rain gaging stations in addition to alluvial aquifer monitor holes.

1.2.2 Surface Water Data Collection

Surface water quality data obtained from the stream gaging stations are reduced by the WRD of the USGS and presented to RBOSP in computer printout form. RBOSP Progress Report 6 contains the data from each station that were available through the month of February 1976. The surface water data collection program was described in detail in RBOSP Progress Reports 2 and 3. Table 1.2-2 presents a data collection schedule and constituents to be analyzed from samples at the stream gaging stations. Major stream water quality constituents over this past reporting period continue to be bicarbonate, dissolved solids, calcium, sulfate, sodium, and magnesium. Flow from October through December 1975 (period for which data are available for this report) was reported at the following gaging stations: Corral Gulch west of Tract C-a, Corral Gulch east of Tract C-a, Corral Gulch south of 84 Mesa, and Yellow Creek near White River. A summary of continuous discharge, continuous conductivity, and continuous temperature is given on Tables 1.2-3 and 1.2-4.

TABLE 1.2-1

LOCATION AND USGS IDENTIFICATION NUMBERS
FOR SURFACE AND RAIN GAGING STATIONS

USGS Identification Number	LOCATION
09306237	Dry Fork near west line Tract C-a
09306235	Corral Gulch near west line Tract C-a
09306240	Box Elder Gulch near west line Tract C-a
09306242	Corral Gulch east of Tract C-a
09306230	Stake Springs Draw near confluence with Corral Gulch
09306255	Yellow Creek near White River, Colorado
09306241	"Rinky Dink" Gulch near east line Tract C-a
09306248	Upper Big Duck Creek north of 84 Mesa
09306250	Lower Big Duck Creek north of 84 Mesa
09306246	Tributary to Yellow Creek east of 84 Mesa
09306244	Corral Gulch near 84 Ranch
	STORAGE-TYPE RAIN GAGES
09306235	Corral Gulch near west line Tract C-a
09306237	Dry Fork near west line Tract C-a
09306240	Box Elder Gulch near west line Tract C-a
	RAINFALL INTENSITY AND RECORDING RAIN GAGES
09306230	Stake Springs Draw near confluence with Corral Gulch
09306255	Yellow Creek near White River, Colorado
No number	Cathedral Bluffs located in NW1/4, NW1/4, Sec. 14 T2S, R100W

Figure 1.2-1
STREAM GAGING STATIONS,
RAIN GAGING STATIONS
AND
ALLUVIAL AQUIFER MONITORING HOLES

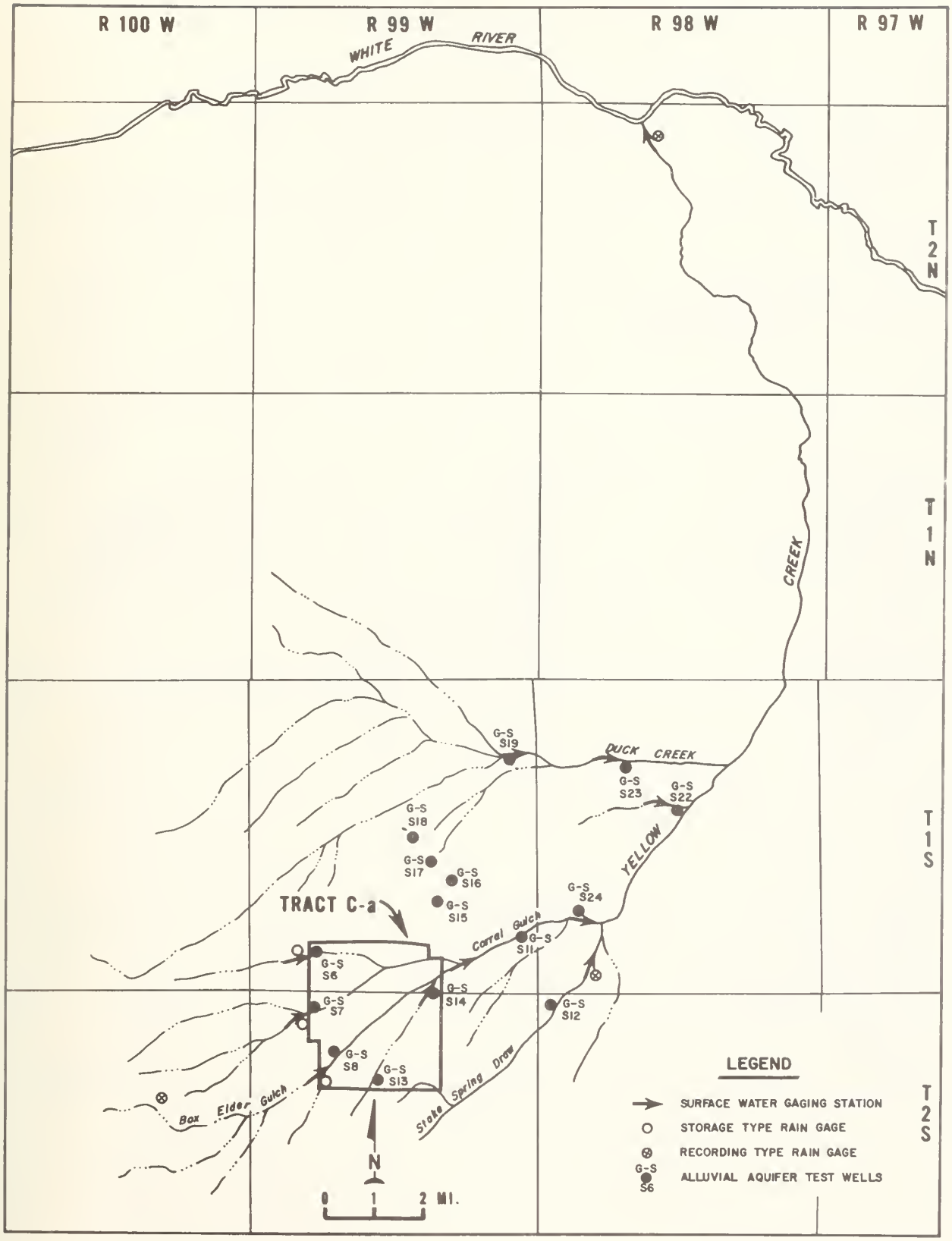


TABLE 1.2-2

DATA COLLECTION SCHEDULE FOR STREAM GAGING STATIONS

Continuously or Automatically

- Flow Rate
- Sediment Discharge
- Temperature
- Specific Conductance

Periodically

- Storage Rain Gages
- Recording Rain Gages
- Rainfall Intensity Gages

Monthly

Water Samples Analyzed For:

- Alkalinity
- Biological Oxygen Demand
- Dissolved Organic Carbon
- Boron
- Calcium
- Conductance
- Fluoride
- Magnesium
- Potassium
- Silica
- Sodium
- Sulfate
- Ammonia
- Bicarbonate
- Carbonate
- Chloride
- Color
- Dissolved Solids
- Kjeldahl Nitrogen
- Nitrate plus Nitrite
- Odor
- Dissolved Phosphate
- Turbidity
- Dissolved Oxygen
- pH
- Temperature
- Total Phosphate
- Ortho Phosphate
- Suspended Organic Carbon

Quarterly

Sample and Analyze:

- COD
- Fecal Coliform
- Pesticides
- Polycyclic Aromatics
- Total Coliform
- Bromide
- Cyanide
- MBAS
- Oil & Grease
- Phenols
- Sulfide
- Radioactivity
  - Gross Alpha
    - 4 pci/l
    - ^{226}Ra
  - Gross Beta
    - 100 pci/l
    - ^{90}Sr
    - ^{137}Ce
- Ba
- Be
- Ge
- Ga
- Ni
- Ti
- V
- Zr
- Al
- As
- Cd
- Cr
- Cu
- Fe
- Pb
- Li
- Mn
- Mo
- Hg
- Se
- Sr
- Zn

TABLE 1.2-3

SELECTED STREAM PARAMETERS FROM CONTINUOUS TYPE DATA

Quarterly Period
OCTOBER 1975 to JANUARY 1976

CORRAL GULCH NEAR WEST LINE TRACT C-a
CORRAL GULCH NEAR EAST LINE TRACT C-a

CORRAL GULCH NEAR WEST LINE TRACT C-a	Oct.	Nov.	Dec.	Jan.
Discharge (cfs)				
Maximum	0.50	0.40	0.07	
Minimum	0	0.03	0.03	
Mean	0.42	0.28	0.04	
Conductivity (umhos)				
Maximum	1060	---	---	
Minimum	255	---	---	
Mean	815	---	---	
Temperature (°C)				
Maximum	18.5	---	---	
Minimum	- 0.5	---	---	
Mean	---	---	---	
CORRAL GULCH NEAR EAST LINE TRACT C-a				
Discharge (cfs)				
Maximum	0.68	0.68	0.50	0.50
Minimum	0.50	0.46	0.46	0.31
Mean	0.55	0.57	0.47	---
Conductivity (umhos)				
Maximum	1810	1480	---	---
Minimum	1130	1160	---	---
Mean	1290	---	---	---
Temperature (°C)				
Maximum	15.5	11.0	---	---
Minimum	6.0	6.0	---	---
Mean	10.0	---	---	---

--- Data not reported by USGS-WRD.

TABLE 1.2-4

SELECTED STREAM PARAMETERS FROM CONTINUOUS TYPE DATA

OCTOBER 1975 to JANUARY 1976

CORRAL GULCH SOUTH OF 84 MESA
YELLOW CREEK NEAR WHITE RIVER

CORRAL GULCH NEAR WEST LINE TRACT C-a	Oct.	Nov.	Dec.	Jan.
Discharge (cfs)				
Maximum	0.19	0.17	.09	---
Minimum	---	---	---	---
Mean	---	---	---	---
Conductivity (umhos/cm)				
Maximum	2000	2680	1700	---
Minimum	1800	1100	---	---
Mean	---	---	---	---
Temperature (°C)				
Maximum	9.5	12.0	---	6.0
Minimum	---	0.5	---	---
Mean	---	---	---	---
YELLOW CREEK NEAR WHITE RIVER				
Discharge (cfs)				
Maximum	5.1	2.9	1.9	1.7
Minimum	1.0	1.4	1.0	0.9
Mean	1.59	2.31	1.82	1.25
Conductivity (umhos/cm)				
Maximum	3210	3060	453*	---
Minimum	2460	409*	328*	---
Mean	2970	---	---	---
Temperature (°C)				
Maximum	31.0	36.0	---	---
Minimum	8.0	6.5	---	---
Mean	15.5	---	---	---

--- Data not reported by USGS-WRD.
*Values abnormally low USGS-WRD reported equipment malfunction.

No runoff occurred which would have significantly increased the flow at any of the three stations on Corral Gulch during the reporting period. Flow decreased from October through December 1975 for all three stations. Conductivity at Corral Gulch east of Tract C-a continued to decline in October from a high in mid-September. The boron and fluoride concentrations from the Corral Gulch near West Line Tract C-a stream gaging station have remained within the stable pattern that has been evidenced throughout 1975. At the Corral Gulch gaging station east of Tract C-a, boron and fluoride values have dropped to near yearly low concentrations. The relatively sudden drop in concentrations occurred near the end of October 1975 during a widespread high precipitation event. The following items exceeded USPHS drinking water standards for the indicated percent of samples taken at the three stream gaging stations on Corral Gulch:

Item	Percent (%) of Samples Exceeding Standard	Drinking Water Standard (mg/l)
Dissolved Solids	40%	500(1)
Sulfate	30%	250(1)
Sodium	20%	115(2)

(1) Recommended concentrations established by U. S. Public Health Service and adopted by Colorado Department of Health.
(2) Unestablished concentration but suggested by U. S. Public Health Service and adopted by Colorado Department of Health.

Tables 1.2-5, 1.2-6 and 1.2-7 are summaries of the water quality data from the three stream gaging stations located on Corral Gulch.

Discharge of the Yellow Creek stream gaging station increased sharply in mid-October. Sharp peaks on October 22 and November 1 are associated with precipitation. Flow decreased from mid-November through December. Boron and fluoride values recorded for Yellow Creek near White River dropped to very low levels by late October and then climbed to near record high values near mid-November. The boron has since dropped toward the yearly average value. Overall, constituent concentrations remained close to preceding sample values. Table 1.2-8 is a summary of the water quality data available from the Yellow Creek stream gaging station.

The following items exceeded drinking water standards for the indicated percent of samples taken at Yellow Creek station:

Table 1.2-5

SUMMARY WATER ANALYSES, RBOSP
STREAM GAGING STATION, U.S.G.S. 09306235
CORRAL GULCH NEAR WEST LINE TRACT C-a

	9/8/75	9/24/75	1/31/75	1/02/75
1. Alkalinity (mg/l)	341	334	354	343
2. Aluminum (ug/l)	40		40	0
3. Ammonia (mg/l)	.00	.01	.00	.12
4. Aromatics, Polycyclic				
5. Arsenic (ug/l)	6	4	3	4
6. Barium (ug/l)	<200	<200		100
7. Beryllium (ug/l)	<1	<1		
8. Bicarbonate (mg/l)	416	407	431	418
9. Bismuth (ug/l)	<5			
10. Boron (ug/l)	100	100	100	90
11. Cadmium (ug/l)	2	0		3
12. Carbonate (mg/l)	0	0	0	0
13. Carbon Dioxide (mg/l)	4.2	3.3		
14. Chloride (mg/l)	7.5	7.3	7.4	11
15. Chromium (ug/l)	0	10		0
16. Cobalt (ug/l)	<3			
17. COD	16			12
18. Coliform, Total & Fecal				
19. Color (PCU)			5	5
20. Conductivity, Specific	1050	1100	1080	1100
21. Copper (ug/l)	5	1		6
22. Cyanide (mg/l)	.00	.00		.00
23. Discharge (CFS)				
24. Discharge, Instantaneous	.27	.44		.05
25. Dissolved Oxygen (mg/l)	9.0	9.8	11.0	
26. Fluoride (mg/l)	.3	.3	.2	.3
27. Gallium (ug/l)	<3			
28. Germanium (ug/l)	<5			
29. Hardness (Ca, Mg) (mg/l)	470	480	470	490
30. Hardness, Non-Carbonate (mg/l)	130	150	120	140
31. Iron (ug/l)	0	40	40	70
32. Kjeldahl Nitrogen (mg/l)	.43	.64	.40	.69
33. Lead (ug/l)	4	1		2
34. Lithium (ug/l)	20	20		20
35. Magnesium (mg/l)	60	61	59	60
36. Manganese (ug/l)	0	10		
37. Mercury (ug/l)	.0	.0		.0
38. Molybdenum (ug/l)	46			
39. Nickel (ug/l)	<5			
40. Nitrate (mg/l)	3.8	3.4		
41. Nitrite (mg/l)	.03	.03		
42. Nitrite Plus Nitrate (mg/l)	.86	.78	.94	1.1
43. Nitrogen, Ammonia	.00	.01	.00	.09
44. Odor (Severity)	0	0		
45. Oil & Grease (mg/l)	1	0		0
46. Ortho-Phosphate (mg/l)				
47. Ortho-Phosphorus (mg/l)	.00	.01	.01	.00
48. Pesticides				
49. pH	8.2	8.3	8.4	
50. Phosphorus, Total (mg/l)	.07	.06	.00	.02
51. Potassium (mg/l)	1.2	1.1	.9	1.5
52. Selenium (ug/l)	3	3		2
53. Silica (mg/l)	21	21	20	19
54. Silver (ug/l)	0			
55. Sodium (mg/l)	86	89	84	84
56. Sodium Adsorption Ratio	1.7	1.8	1.7	1.7
57. Sodium (%)	28	29	28	27
58. Solids, Dissolved (mg/l)	756	767	760	794
59. Solids, Dissolved T/D	.55	.91		.11
60. Solids, Dissolved T/Ac-Ft	1.03	1.04	1.03	1.08
61. Solids, Suspended				
62. Strontium (ug/l)	1400		1800	1900
63. Sulfate (mg/l)	280	290	280	310
64. Sulfide (mg/l)	.3	.0		.0
65. Temperature (°C)	12.0	13.5	1.5	.5
66. Tin (ug/l)	<5			
67. Titanium (ug/l)	<3			
68. Turbidity (JTU)	2	20		
69. Vanadium (ug/l)	<3.0			
70. Zinc (ug/l)	10	10		20
71. Zirconium (ug/l)				
72. Calcium (mg/l)	90	93	90	95
73. Complete Element Span				
74. Radioactivity				
Gross Alpha (pci)	<8.9			
Radium 226*				
Gross Beta				
Thorium 230**				
Uranium**				
75. Total Organic Carbon (mg/l)	8.0		11.5	16.5
If TOC >10 mg/liter, then				
Nitrogen (Base Extraction)				
Organic Carbon, Dissolved				
Organic Carbon, Suspended				
Phenols				
Sulfur (Acid Extraction)				
76. Total Ortho-Phosphorous (mg/l)	.01	.01		
77. Phosphate			.00	.06
78. Phosphorus, Dissolved				

Table 1.2-6

SUMMARY WATER ANALYSIS, RBOSP
STREAM GAGING STATION U.S.G.S. 09306242
CORRAL GULCH EAST OF TRACT C-a

	8/27/75 1130	9/8/75 1430	9/24/75 1225	10/24/75 1300	10/30/75 1430	11/18/75 1150	12/24/75 1100
1. Alkalinity (mg/l)	413	406	420	419	412	413	420
2. Aluminum (ug/l)		30				20	10
3. Ammonia (mg/l)	.00	.00	.03	.03	.06	.00	.03
4. Aromatics, Polycyclic							
5. Arsenic (ug/l)	4	7	6	5	5	4	4
6. Barium (ug/l)	<200	<200	<200	100	100		200
7. Beryllium (ug/l)		< 2					
8. Bicarbonate (mg/l)	503	495	512	511	502	504	512
9. Bismuth (ug/l)		<6					
10. Boron (ug/l)	150	150	160	150	130	140	120
11. Cadmium (ug/l)	0	0	0	1	0		1
12. Carbonate (mg/l)	0	0	0	0	0	0	0
13. Carbon Dioxide (mg/l)	16	13	21				
14. Chloride (mg/l)	9.7	11	10	11	10	11	8.5
15. Chromium (ug/l)	50	0	10	4	0		0
16. Cobalt (ug/l)		<3					
17. COD							11
18. Coliform, Total & Fecal							
19. Color (PCU)				4	5	4	4
20. Conductivity, Specific	1100	1200	1300	1300	1300	1150	1200
21. Copper (ug/l)	1	2	1	7	1		4
22. Cyanide (mg/l)	.00	.00	.00	.00	.00		.00
23. Discharge (CFS)							
24. Discharge, Instantaneous	.66	.57	.34	.56	.56	.58	.50
25. Dissolved Oxygen (mg/l)	---	9.0	10.3	9.2	7.6	12.0	
26. Fluoride (mg/l)	.5	.5	.5	.6	.5	.4	.4
27. Gallium (ug/l)		<3					
28. Germanium (ug/l)		<6					
29. Hardness (Ca, Mg) (mg/l)	490	470	490	460	460	490	470
30. Hardness, Non-Carbonate (mg/l)	73	64	74	44	47	78	52
31. Iron (ug/l)	10	50	10	10	40	30	10
32. Kjeldahl Nitrogen (mg/l)	.30	.25	.48			.34	.21
33. Lead (ug/l)	0	2	3	0	3		2
34. Lithium (ug/l)	10	10	10	10	10		10
35. Magnesium (mg/l)	67	65	66	59	63	66	60
36. Manganese (ug/l)	10	10	20				
37. Mercury (ug/l)	.0	.0	.0	.0	.0		.0
38. Molybdenum (ug/l)		56					
39. Nickel (ug/l)		<6					
40. Nitrate (mg/l)	1.2	1.2	1.2				
41. Nitrite (mg/l)	.03	.03	.03				
42. Nitrite Plus Nitrate (mg/l)	.29	.27	.29	.21	.26	.29	.26
43. Nitrogen, Ammonia	.00	.00	.03	.02	.05	.00	.02
44. Odor (Severity)		0	0				
45. Oil & Grease (mg/l)	1	1	2		0		0
46. Ortho-Phosphate (mg/l)							
47. Ortho-Phosphorus (mg/l)	.02	.02	.03				
48. Pesticides							
49. pH	7.7	7.8	7.6	8.0	8.2	7.8	7.7
50. Phosphorus, Total (mg/l)	.00	.04	.07	.03	.01	.03	.03
51. Potassium (mg/l)	1.7	1.5	1.3	1.6	1.6	1.4	1.7
52. Selenium (ug/l)	1	2	3	1	3		1
53. Silica (mg/l)	21	21	21	19	20	20	20
54. Silver (ug/l)		0					
55. Sodium (mg/l)	120	120	120	130	110	120	110
56. Sodium Adsorption Ratio	2.4	2.4	2.4	2.6	2.2	2.4	2.2
57. Sodium ( )	35	36	35	38	34	35	34
58. Solids, Dissolved (mg/l)	834	836	852	762	824	858	826
59. Solids, Dissolved T/D	1.49	1.29	.78	1.15	1.25	1.34	1.12
60. Solids, Dissolved T/Ac-Ft	1.13	1.14	1.16	1.04	1.12	1.17	1.12
61. Solids, Suspended							
62. Strontium (ug/l)		1400				1900	1900
63. Sulfate (mg/l)	280	290	290	200	290	300	280
64. Sulfide (mg/l)	.0	.2	.0	.0	0		1
65. Temperature (°C)	15.5	11.0	12.0	9.0	9.5	8.0	7.5
66. Tin (ug/l)		<6					
67. Titanium (ug/l)		<3					
68. Turbidity JTU)	2	0	2				
69. Vanadium (ug/l)		4.0					
70. Zinc (ug/l)	0	0	10	20	0		10
71. Zirconium (ug/l)							
72. Calcium (mg/l)	84	81	89	88	80	87	89
73. Complete Element Span							
74. Radioactivity							
Gross Alpha (pci)		<6.7					
Radium 226*							
Gross Beta		9.4					
Thorium 230**							
Uranium**							
75. Total Organic Carbon (mg/l)						14.5	8.7
If TOC 10 mg/liter, then							
Nitrogen (Base Extraction)							
Organic Carbon, Dissolved							
Organic Carbon, Suspended							
Phenols							
Sulfur (Acid Extraction)							
76 Total Ortho-Phosphorous (mg/l)	.02	.04	.03	.02	.02	.03	.03
77. Phosphate				.09	.03	.09	.09
78. Phosphorus, Dissolved							

Table 1.2-7

SUMMARY WATER ANALYSIS, RBOSP
STREAM GAGING STATION U.S.G.S. 09306244
CORRAL GULCH NEAR 84 RANCH

	6/12/75 1300	6/25/75 1300	7/15/75 1330	7/30/75 1430	9/9/75 0930	7/24/75 1345	10/29/75 1400	12/31/75 1545	11/18/75 1300	12/25/75 1200
1. Alkalinity (mg/l)	532	477	523	525	540	479	513	514	520	520
2. Aluminum (ug/l)	50				20				20	10
3. Ammonia (mg/l)	.01	.00	.00	.05	.00	.06	.00	.03	.03	.13
4. Aromatics, Polycyclic										
5. Arsenic (ug/l)	3	3	5	6	7	4	4	4	3	2
6. Barium (ug/l)	0	0	200	0	<200	100	100	100		100
7. Beryllium (ug/l)	<4				<2					
8. Bicarbonate (mg/l)	649	582	638	640	658	584	626	627	634	634
9. Bismuth (ug/l)	<9				<9					
10. Boron (ug/l)	190	160	190	150	210	190	190	170	190	160
11. Cadmium (ug/l)	0	0	1	1	0	1	0	0		1
12. Carbonate (mg/l)	0	0	0	0	0	0	0	0	0	0
13. Carbon Dioxide (mg/l)	3.3	2.3	4.1	3.2	8.4	7.4				
14. Chloride (mg/l)	19	21	23	21	19	19	21	19	19	17
15. Chromium (ug/l)	10	0	10	0	0	10	10	0		0
16. Cobalt (ug/l)	<9				4					
17. COD										11
18. Coliform, Total & Fecal										
19. Color (PCU)							10	0	5	0
20. Conductivity, Specific	2000	1780	2000	1900	1800	980	1800	2000	1700	1700
21. Copper (ug/l)	0	1	1	2	3	2	2	1		6
22. Cyanide (mg/l)	.00	.01	.00	.00	.00	.00	.00	.00		.00
23. Discharge (CFS)										
24. Discharge, Instantaneous	---	.81	.50	.72	.27	.43	.19	.19	.17	.09
25. Dissolved Oxygen (mg/l)	4.4	10.4	7.6	13.8	10.2	7.9	18.1	9.0		
26. Fluoride (mg/l)	.3	.3	.3	.4	.3	.3	.3	.3	.3	.3
27. Gallium (ug/l)	<4				<4					
28. Germanium (ug/l)	<13				<9					
29. Hardness (Ca, Mg) (mg/l)	750	790	760	790	790	650	690	730	690	730
30. Hardness, Non-Carbonate (mg/l)	220	320	240	270	250	170	170	210	170	210
31. Iron (ug/l)	80	120	40	60	0	10	10	60	80	10
32. Kjeldahl Nitrogen (mg/l)	.42	.43	.79	.86	.41	1.6			1.0	.71
33. Lead (ug/l)	0	1	8	0	1	3	3	3		2
34. Lithium (ug/l)	10	20	0	0	0	10	10	5		10
35. Magnesium (mg/l)	110	120	100	120	120	91	100	110	100	110
36. Manganese (ug/l)	80	10	250	190	110	120				
37. Mercury (ug/l)	.0	.1	.0	.0	.0	.1	.0	.0		.0
38. Molybdenum (ug/l)	60				55					
39. Nickel (ug/l)	<9				<9					
40. Nitrate (mg/l)	.22	5.7	2.2	3.9	2.8	3.2				
41. Nitrite (mg/l)	.00	.07	.13	.16	.13	.10				
42. Nitrite Plus Nitrate (mg/l)	.05	1.3	.54	.94	.68	.78	.23	.32	.66	.38
43. Nitrogen, Ammonia	.01	.00	.00	.04	.00	.05	.00	.02	.02	.10
44. Odor (Severity)	0	0	0	0	0	0				
45. Oil & Grease (mg/l)	0	2	4	1	2	1		0		0
46. Ortho-Phosphate (mg/l)										
47. Ortho-Phosphorus (mg/l)										
48. Pesticides										
49. pH	7.5	8.6	8.4	8.5	8.1	8.1	8.1	8.3	8.1	7.9
50. Phosphorus, Total (mg/l)	.01	.36	.04	.02	.02	.00	.01	.00	.00	.03
51. Potassium (mg/l)	1.9	2.4	4.4	4.1	2.8	2.8	3.3	3.0	2.4	2.8
52. Selenium (ug/l)	1	6	3	3	2	3	1	1	1	1
53. Silica (mg/l)	19	15	21	17	20	17	17	17	18	18
54. Silver (ug/l)	<1				<1					
55. Sodium (mg/l)	190	170	180	190	180	170	200	180	190	180
56. Sodium Adsorption Ratio	3.0	2.6	2.8	2.9	2.8	2.9	3.3	2.9	3.2	2.9
57. Sodium ( )	35	32	34	34	33	36	39	35	38	35
58. Solids, Dissolved (mg/l)	1370	1320	1390	1370	1360	1210	1280	1340	1330	1310
59. Solids, Dissolved T/D	---	2.89	1.88	2.66	.99	1.40	.66	.69	.61	.32
60. Solids, Dissolved T Ac-Ft	1.86	1.80	1.89	1.86	1.85	1.65	1.74	1.82	1.81	1.78
61. Solids, Suspended										
62. Strontium (ug/l)	2500				2300				2700	2700
63. Sulfate (mg/l)	590	580	600	580	570	510	520	590	570	550
64. Sulfide (mg/l)	.0	.0	.1	.0	.0	.0	.0	.1		.0
65. Temperature (°C)	10.0	13.0	20.0	23.0	12.0	20.5	9.5	9.0	7.0	6.0
66. Tin (ug/l)	<9				<9					
67. Titanium (ug/l)	<5				<4					
68. Turbidity (JTU)	2	20	6	5	0	1				
69. Vanadium (ug/l)	<9.0				<4.0					
70. Zinc (ug/l)	10	10	10	20	10	10	0	0		40
71. Zirconium (ug/l)										
72. Calcium (mg/l)	120	120	140	120	120	110	110	110	110	110
73. Complete Element Spar										
74. Radioactivity										
Gross Alpha (pc/l)										
Radium 226*										
Gross Beta										
Thorium 230**										
Uranium**										
75. Total Organic Carbon (mg/l)	11								14	9.6
If TOC 10 mg/liter, see:										
Nitrogen (Base Extraction)										
Organic Carbon, Dissolved										
Organic Carbon, Suspended										
Phenols										
Sulfur (Acid Extraction)										
76. Total Ortho-Phosphorus	.01	.00	.01	.01	.01	.01	.01	.01	.01	.01
77. Phosphate							.03	.00	.00	.09
78. Phosphorus, Dissolved	.01	.00	.02	.00	.01	.01				

Table 1.2-8

SUMMARY WATER ANALYSES, RBOSP
STREAM GAGING STATION U.S.G.S. 09306255
YELLOW CREEK NEAR WHITE RIVER

	9/10/75 1205	9/24/75 1045	10/8/75 1000	10/31/75 1330	11/21/75 1130	12/18/75 1000
1. Alkalinity (mg/l)	1550	1560	1590	1200	1620	1660
2. Aluminum (ug/l)	75				70	0
3. Ammonia (mg/l)	0.0	0.04	0.04	.01	0	.28
4. Aromatics, Polycyclic						
5. Arsenic (ug/l)	4	7	5	5	4	4
6. Barium (ug/l)	200	200	200	100	100	600
7. Beryllium (ug/l)	<4					<10
8. Bicarbonate (mg/l)	1620	1900	1790	1300	1600	1680
9. Bismuth (ug/l)	<20					<50
10. Boron (ug/l)	770	680	690	610	750	690
11. Cadmium (ug/l)	1	1	0	1	1	1
12. Carbonate (mg/l)	135	0	75	82	182	172
13. Carbon Dioxide (mg/l)	0.2	24	7.8			
14. Chloride (mg/l)	150	140	130	110	150	130
15. Chromium (ug/l)	80	10	0	4		0
16. Cobalt (ug/l)	<10					<45
17. COD						17
18. Coliform, Total & Fecal						
19. Color (PCU)			10	80	13	4
20. Conductivity, Specific	4000	4000	4000	3500	5000	4000
21. Copper (ug/l)	4	4	0	5		4
22. Cyanide (mg/l)	0	0	0	.00	.00	.00
23. Discharge (CFS)						
24. Discharge, Instantaneous	0.0	1.3	0.92		2.4	
25. Dissolved Oxygen (mg/l)	9.9	12.2			12.5	12.5
26. Fluoride (mg/l)	2.3	2.3	2.1	1.8	2.4	2.4
27. Gallium (ug/l)	<10					<10
28. Germanium (ug/l)						<50
29. Hardness (Ca, Mg) (mg/l)	520	570	570	450	550	650
30. Hardness, Non-Carbonate (mg/l)	0	0	0	0	0	0
31. Iron (ug/l)	20	10	10	120	70	20
32. Kjeldahl Nitrogen (mg/l)	0.89	0.48	0.76		.63	1.0
33. Lead (ug/l)	4	0	0	1		2
34. Lithium (ug/l)	120	160	150	100		160
35. Magnesium (mg/l)	110	120	120	88	110	130
36. Manganese (ug/l)	0	10	10			50
37. Mercury (ug/l)	0.0	0.0	0.1	0		0
38. Molybdenum (ug/l)	55					70
39. Nickel (ug/l)	<20					<45
40. Nitrate (mg/l)	2.8	3.4	2.9			
41. Nitrite (mg/l)	0.2	0.03	0.03			
42. Nitrite Plus Nitrate (mg/l)	0.7	0.78	0.66	.56	1.5	1.4
43. Nitrogen, Ammonia	.00	.03	.03	.01	.00	.22
44. Odor (Severity)	0	0	0			
45. Oil & Grease (mg/l)	1	0	0			0
46. Ortho-Phosphate (mg/l)						
47. Ortho-Phosphorus (mg/l)			0	.01	.01	.07
48. Pesticides						
49. pH	10.1	8.1	8.6	8.8	8.4	8.5
50. Phosphorus, Total (mg/l)			.02	.28	.00	.11
51. Potassium (mg/l)	4.8	3.7	4.3	6.5	4.1	4.2
52. Selenium (ug/l)	2	2	2	3		2
53. Silica (mg/l)	8.9	9.3	6.4	5.3	8.9	14
54. Silver (ug/l)	< 2					<5
55. Sodium (mg/l)	820	830	800	680	850	870
56. Sodium Adsorption Ratio	16	15	15	13	16	15
57. Sodium (%)	77	76	75	75	77	74
58. Solids, Dissolved (mg/l)	2570	2600	2640	2130	2700	2870
59. Solids, Dissolved T/D		9.69	6.56		18.0	
60. Solids, Dissolved T/Ac-Ft	3.5	3.54	3.59	2.90	3.67	3.90
61. Solids, Suspended						
62. Strontium (ug/l)	3000				3500	3800
63. Sulfate (mg/l)	510	520	580	510	560	660
64. Sulfide (mg/l)	0.0	0.0	0.2	.0	.0	0
65. Temperature (°C)	19.5	8.5	1.5	10.0	.0	.0
66. Tin (ug/l)	<20					<50
67. Titanium (ug/l)	<10					<50
68. Turbidity (JTU)	20	20	5			
69. Vanadium (ug/l)	<10					<40
70. Zinc (ug/l)	0	10	10	2		0
71. Zirconium (ug/l)						<100
72. Calcium (mg/l)	25	31	32	37	37	44
73. Complete Element Span						
74. Radioactivity						
Gross Alpha (pci)						
Radium 226*						
Gross Beta						
Thorium 230**						
Uranium**						
75. Total Organic Carbon (mg/l)	29				14.2	7.7
If TOC 10 mg/liter, then						
Nitrogen (Base Extraction)						
Organic Carbon, Dissolved	22					
Organic Carbon, Suspended						
Phenols						
Sulfur (Acid Extraction)						
76. Total Ortho-Phosphorous (mg/l)	0.2	0.2	0.2			
Phosphate			.06	.86	.00	.34
78. Phosphorus, Dissolved	0.04	0.04	0.02			

Item	Percent (%) of Samples Exceeding Standard	Drinking Water Standard (mg/l)
Dissolved Solids	100%	500(1)
Sulfate	100%	250(1)
Sodium	100%	115(2)
Bicarbonate	100%	700(2)
Carbonate	100%	20(2)
Magnesium	25%	125(3)

(1) Recommended concentration established by U. S. Public Health Service and adopted by Colorado Department of Health.
(2) Unestablished concentration but suggested by U. S. Public Health Service and adopted by Colorado Department of Health.
(3) Recommended concentration established by Colorado Department of Health.

The three types of gages used for collecting precipitation data are the storage precipitation type, the recording type gage, and the rainfall-intensity type. No new storage gage data were received from the USGS-WRD for this quarter. Wide-spread precipitation, as evidenced by correlation between instantaneous gages, appeared to have occurred on: October 7, 22, and 31, and December 14 and 31, 1975. Intensity and duration of precipitation events were usually greatest at the Cathedral Bluffs station which is at the highest elevation of all the rain gages. A precipitation summary is given in Table 1.2-9.

1.2.3 Alluvial Aquifers

The drilling and completion of fifteen alluvial aquifer test holes was described in RBOSP Progress Reports 2, 3 and 4. The holes which encountered water were: G-S S-7, G-S S-8, G-S S-11, G-S S-12, G-S S-19, G-S S-22, G-S S-23 and G-S S-24. Water quality information, conductivity, temperature, pH, and water levels are being monitored. Dry holes include G-S S-6, S-13 and S-14, and those located near 84 Mesa: G-S S-15, G-S S-16, G-S S-17, and G-S S-18. Figure 1.2-1 shows the location of each of the alluvial monitoring holes.

In reference to the previous quarterly reporting period water levels dropped in most alluvial holes from September through November as shown by Table 1.2-10. However, minor increases in water levels then occurred at corresponding dates near mid-October 1975, in G-S S-12, G-S S-24, G-S S-22 and G-S S-23, which corresponds to a wide ranging precipitation event detected over the Tract. G-S S-7 has had a steadily increasing water level since mid-October 1975. G-S S-8 experienced slightly dropping water levels. Water in G-S S-11 was relatively stable. Water level in G-S S-19 in Upper Duck Creek had a gradually rising water level, which then rose rapidly on November 20, 1975. However, on January 28, 1975 the water level in G-S S-19 fell sharply. Conductivities and pH have remained relatively stable

TABLE 1.2-9

PRECIPITATION SUMMARY

October - December, 1975

Recording Type Rain Gage Locations	October *			November			December		
	Inches Maximum	Inches Total	Number of Days	Inches Maximum	Inches Total	Number of Days	Inches Maximum	Inches Total	Number of Days
Stake Springs Draw near confluence with Corral Gulch	.74	1.51	5	.47	1.09	9	.32	.88	5
Yellow Creek near White River	.55	1.91	5	.42	1.12	9	.13	0.47	6
Cathedral Bluffs located in NW1/4, NW1/4, Sec. 14, T2S, R100W	.77	2.49	7	.40	1.41	12	.34	1.01	4

*Data reported previously in Progress Report 5 -- presented again here to demonstrate seasonal precipitation trends.

Table 1.2-10

ALLUVIAL HOLES

COMPARATIVE WATER DEPTHS

QUARTERLY PERIOD
DECEMBER, 1975 - FEBRUARY, 1975

Hole No.	September - November Depth in Feet			December - February Depth in Feet		
	Maximum	Minimum	Quarterly* Change	Maximum	Minimum	Quarterly Change
G-S S- 6			dry			dry
G-S S- 7	24.8	23.7	+0.6	22.2	18.7	+3.5
G-S S- 8	36.8	32.0	-4.8	38.4	37.4	-1.0
G-S S-11	44.3	42.8	-1.5	44.7	44.6	-0.1
G-S S-12	35.5	33.2	-2.3	34.0	33.5	+0.5
G-S S-13			dry			dry
G-S S-14			dry			dry
G-S S-15			dry			dry
G-S S-16			dry			dry
G-S S-17			dry			dry
G-S S-18			dry			dry
G-S S-19	55.1	54.5	+1.4	53.3	50.8	-0.7
G-S S-22	67.5	66.2	-1.3	66.2	65.6	-0.6
G-S S-23	30.3	28.8	-1.5	29.4	28.8	+0.6
G-S S-24	7.4	5.8	-1.6	6.8	6.2	-0.6

*Quarterly change is the difference between the first measurement of the quarter and the last measurement made during the quarter. The signs (+ or -) designate whether the water level has risen (+) or fallen (-) from the first of the quarter to the end of the quarter.

during the past quarter. Temperatures have been dropping due to winter climatic influence.

Major alluvial water quality constituents that were present in alluvial water this past quarter include bicarbonates, dissolved solids, alkalinity, sulfate, calcium, sodium and magnesium. The following items exceeded USPHS drinking water standards for the indicated percent of samples taken:

Item	Percent (%) of Samples Exceeding Standard	Drinking Water Standard (mg/l)
Dissolved Solids	96%	500(1)
Sodium	83%	115(2)
Sulfate	75%	250(1)
Bicarbonate	25%	700(2)
Magnesium	17%	125(3)
Calcium	4%	200(2)

(1) Recommended concentration established by U. S. Public Health Service and adopted by Colorado Department of Health.
(2) Unestablished concentration but suggested by U. S. Public Health Service and adopted by Colorado Department of Health.
(3) Recommended concentration established by Colorado Department of Health.

A water quality summary is shown in Tables 1.2-11 and 1.2-12. Samples are to be taken in February, July, and November, and monthly during the snowmelt-flash flood seasons.

1.2.7 Deep Aquifer Monitoring

The deep aquifer monitoring program was initiated in December 1974, at which time only static water levels were monitored. Sampling programs for the deep aquifer monitor holes began in March 1975, when water samples were collected from the deep aquifers once a month for a period of six months and thereafter once every six months. Water levels are measured monthly and immediately prior to sampling. Figure 1.2-2 shows the location of the deep aquifer monitor holes.

Samples taken every six months from deep wells are analyzed for the following: total alkalinity, Al, ammonia, As, Ba, Be, Bi, HCO_3, Br, B dissolved organic carbon, Ca, CO_3, Cd, Cl, Cr, Cm, cyanide, COD, dissolved solids, Ge, Ga, F, Fe, Pb, Li, Mg, Mn, Hg, No, Ni, nitrate plus nitrite (reported as N) phenols, dissolved phosphate, K, Se, SiO_2, Na, Sr, SO_4, sulfide, Ti, U, Zr, and Zn. Analyses and measurements for color, odor, pH, temperature, and specific conductance

TABLE 1.2-11

WATER QUALITY ANALYSIS SUMMARY

WET CHEMICAL ANALYSIS

ALLUVIAL AQUIFERS

March 1975 - January 1976

Item (mg/l)	Low	High	Average	No. Items Averaged
Alkalinity	329	640	474	91
Aluminum	< 0.1	< 0.1	0.0	4
Ammonia	< 0.1	1.7	.3	80
Arsenic	< 0.0	.01	0.0	91
Barium	< 0.1	0.3	0.003	91
Bicarbonate	370	780	573	91
Boron	< 0.1	27.0	1.2	91
Cadmium	< 0.01	1.1	.03	91
Calcium	28	240	102	91
Carbonate	< 0.1	605.0	11.4	91
Chloride	5.4	71.0	17.9	91
Chromium	< 0.01	< 0.05	0	90
Conductance (umhos/cm)	860	3400	1580	91
Copper	< 0.1	8.0	.5	91
Cyanide	< 0.01	0.02	0.002	91
Dissolved Solids	1120	2880	1193	91
Fluoride	< 0.1	1.2	.4	90
Gross Alpha (pci/l)	1.4	31.0	12.2	87
Gross Beta (pci/l)	1.0	74.0	15.3	32
Hardness (total)	280	820	600	91
Hydroxide	---	---	0	0
Iron	< 0.05	28.0	7.2	91
Lead	0.02	13.0	.4	90
Lithium	---	---	0	0
Magnesium	3.7	150.0	83.9	91
Manganese	< 0.05	27.0	3.1	91
Mercury	0.002	< 0.01	0	91
Nickel	0.01	0.20	0.07	90
Nitrate	< 0.1	165.0	6.6	91
pH	6.0	7.2	6.5	91
Phosphate	< 0.1	0.2	0.01	91
Potassium	---	---	0	0
Selenium	0.01	< 0.1	0	91
Silicon Dioxide	7.4	44.0	31.1	91
Silver	< 0.1	0.07	0.006	90
Sodium	75	850	202	91
Sulfate	145	1720	467	91
Sulfide	---	---	0	0
TOC	3	292	53	87
Zinc	< 0.1	13.0	.8	89

--- Less than minimum detectable amount

TABLE 1.2-12

SUMMARY OF QUALITATIVE SPECTROGRAPHIC ANALYSIS

ALLUVIAL AQUIFER

March 1975 - January 1976

Item (mg/l)	Low	High	Average	No. Items Averaged
Aluminum	0.005	5.000	0.402	90
Antimony	---	---	0	0
Arsenic	---	---	0	0
Barium	0.001	0.050	0.006	40
Beryllium	0.001	0.001	0.001	3
Bismuth	---	---	0	0
Boron	0.01	0.50	0.34	90
Cadmium	---	---	0	0
Calcium	10.0	major	10.0	6
Cerium	---	---	0	0
Cesium	0.001	0.001	0.001	1
Chromium	---	0.01	0.003	9
Cobalt	0.001	0.001	0.001	2
Columbium	---	---	0	0
Copper	0.001	0.050	0.013	89
Dysprosium	---	---	0	0
Erbium	---	---	0	0
Europium	---	---	0	0
Gadolinium	---	---	0	0
Gallium	0.001	0.001	0.001	1
Germanium	0.001	0.001	0.001	1
Gold	---	---	0	0
Hafnium	---	---	0	0
Holmium	---	---	0	0
Indium	---	---	0	0
Iridium	---	---		0
Iron	0.01	2.00	0.18	90
Lanthanum	---	---	0	0
Lead	0.001	0.200	0.032	29
Lithium	0.001	0.100	0.007	77
Lutetium	---	---	0	0
Magnesium	5.0	major	2228	9
Manganese	0.001	0.500	0.062	89
Mercury	---	---	0	0
Molybdenum	0.001	0.050	0.004	50
Neodymium	---	---	0	0
Nickel	0.001	0.070	0.012	6
Osmium	---	---	0	0
Palladium	---	---	0	0
Platinum	---	---	0	0

Table 1.2-12

Continued

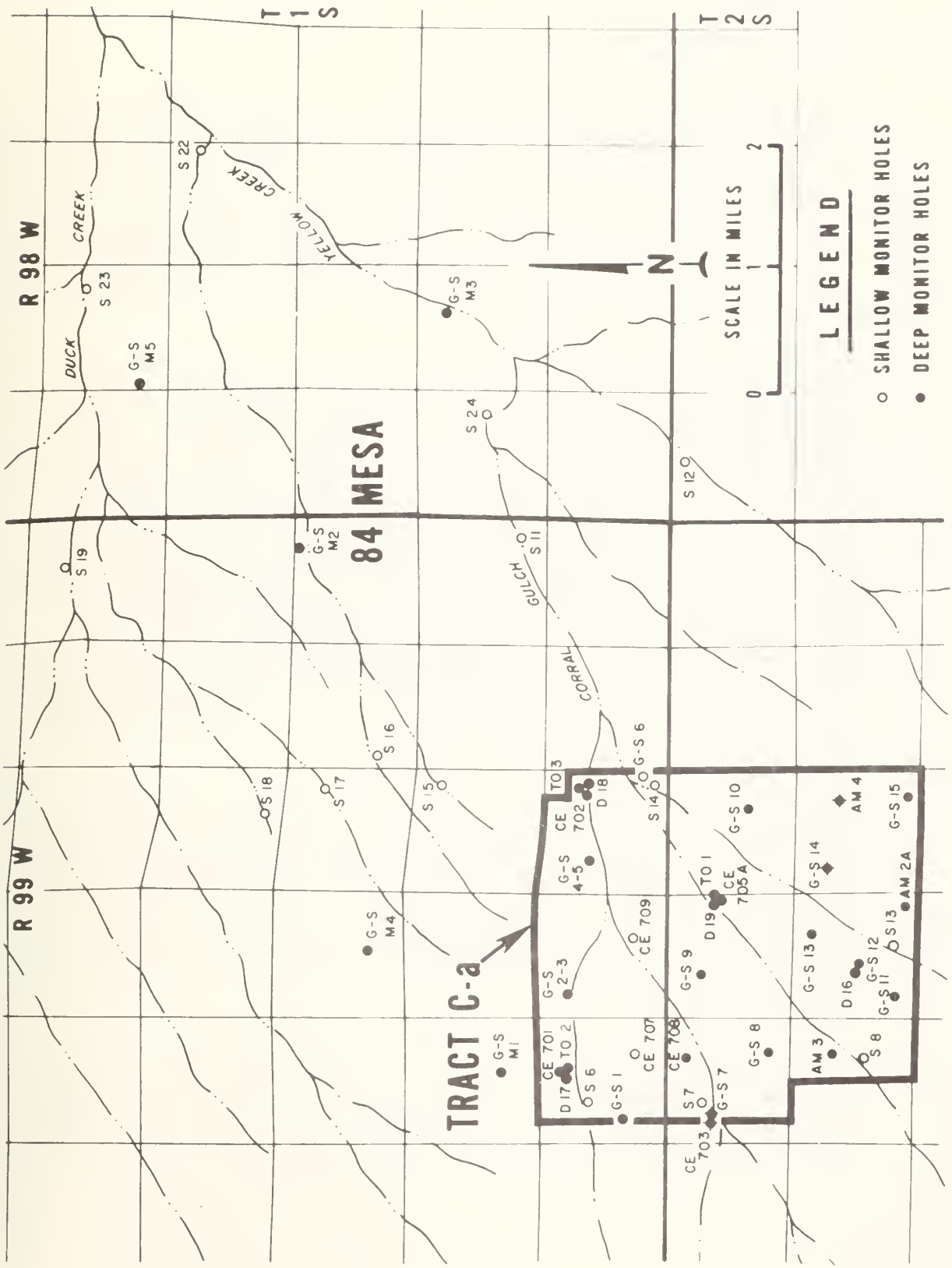
SUMMARY OF QUALITATIVE SPECTROGRAPHIC ANALYSIS

Item (mg/l)	Low	High	Average	No. Items Averaged
Potassium	0.01	2.00	0.66	90
Praseodymium	---	---	0	0
Radium	0.10	1.20	0.34	62
Rhenium	---	---	0	0
Rhodium	---	---	0	0
Rubidium	---	---	0	0
Ruthenium	---	---	0	0
Samarium	---	---	0	0
Scandium	---	---	0	0
Selenium	---	---	0	0
Silicon	2.0	20.0	5.1	90
Silver	0	.020	0.003	28
Sodium	1.0	major	6.4	69
Strontium	0.01	0.10	0.10	87
Tantalium	---	---	0	0
Terbium	---	---	0	0
Thallium	---	---	0	0
Thorium	---	---	0	0
Thulium	---	---	0	0
Tin	0.001	0.001	0.001	7
Titanium	0.001	0.100	0.008	75
Tungsten	---	---	0	0
Uranium	---	---	0	0
Vanadium	0.001	0.010	0.005	8
Ytterbium	0.001	0.001	0.001	6
Yttrium	0.01	0.02	0.01	6
Zinc	0.001	0.020	0.004	37
Zirconium	---	---	0	0

--- Less than minimum detectable amount

Major - Concentration too large to quantify

Figure 1.2-2
LOCATION OF MONITORING HOLES



are made in the field at the time of the sampling. Radioactivity of the water from deep aquifer wells is also determined semi-annually as gross alpha and gross beta. As deep aquifer samples are taken once every six months there are no new deep aquifer analyses to report for the quarter.

1.2.8 Hydrologic Program Summary and Analysis

Precipitation data indicates that winter months generally are frequented by broad frontal system events while summer data show primarily local thunder shower events. Duration and intensity of precipitation apparently is a function of station elevation. The number of precipitation days this past quarter resulting in the total annual precipitation at the relatively high Cathedral Bluffs station was 23 days and 17.2 inches/year respectively. The number of precipitation days this past quarter resulting in the total annual precipitation at the Yellow Creek station (significantly lower elevation) was 20 days and 11.9 inches/year respectively.

The streams on and around Tract C-a can be classified as intermittent; however, some reaches of the streams are perennial. There are three major perennial streams and tributaries within the Piceance Creek and Yellow Creek drainage basin: Piceance Creek, Dry Fork of Piceance Creek, Black Sulphur Creek, and Yellow Creek. Yellow Creek is only perennial along a few miles just above its confluence with the White River. Runoff water from snowmelt may have a lower conductivity than runoff from a thunderstorm due to the gradual nature of snowmelt runoff in comparison to the more rapid runoff from heavy thunderstorms. Rapid runoff will tend to be higher in sediment and presumably higher in dissolved solids. Water flow at the Corral Gulch station east of Tract C-a averages approximately 1 cfs during the year. The average flow at the Yellow Creek stream gaging station near the White River is approximately 1.8 cfs. The perennial flows in the lower reaches of Yellow Creek may be due to artesian contributions by the deep groundwater aquifers.

The alluvial aquifers along the perennial streams are saturated. The alluvium of some of the smaller drainages remained dry (unsaturated) even during the snowmelt runoff period when the highest water table levels were recorded in the alluvium of the major surface drainages. The alluvial aquifers respond to regional and indirectly to local precipitation events. The water quality in the alluvium tends to be generally poorer than the water quality of the surface streams. The alluvium generally shows an increase in dissolved solids in the down gradient direction.

Drilling programs conducted on Tract C-a have indicated two major aquifer systems exist under Tract C-a. The upper aquifer occurs in the vicinity of the Mahogany Zone generally being located both above and below the Mahogany Zone. The lower aquifer is associated with the R-3 Zone. Both the upper and lower aquifers are artesian. The holes on and around Tract C-a have been completed to eliminate

communication between the two aquifer systems. In the NE corner of the tract an interconnection between the upper and lower aquifers still exists which may be the result of naturally occurring faults in the area; inadequate isolation of the two aquifers in one of the three holes located in the NE corner of the tract; and/or possible fracturing as a result of experimental fracturing work done by WRD-USGS in 1973. Long-term pumping tests allowed the calculation of transmissivity and coefficients of storage at various monitoring holes located on and around the tract. Extrapolation of these values indicate apparent transmissivities of 2,500 gpd/ft. and 7,000 gpd/ft. for the upper and lower aquifers respectively. Analysis of the pumping tests reveals: a resultant preferred directional flow in the NNW-SSE direction, that faulting may act as barriers to water movement in the upper aquifer system, leaky conditions exist in the upper aquifer, anisotropic conditions exist in the lower aquifer, and permeability in the lower aquifer increases toward the NW corner of the tract.

Data from the deep aquifer monitoring program basically defines piezometric level and water quality. Collection of data from the monitoring of water levels in the upper and lower aquifers was initiated in December of 1974. Water levels measured prior to that time were affected by commingling of the waters and the hydrostatic heads of the two aquifers. The best water quality in the upper aquifer is located along the western boundary of Tract C-a and in an area surrounding corehole CE-705A. The poorest water quality in the upper aquifer is located in the extreme northeast corner of Tract C-a. The best water quality in the lower aquifer is also found along the western boundary of Tract C-a and the poorest quality in the extreme northeast corner of the tract. High iron values are thought to be the result of a reaction between the aquifer waters and the steel casing in the drill and coreholes.

ABSTRACT

This report presents the progress of the RBOSP environmental baseline studies during the sixth quarter of study - December 1975 through February 1976. Data collection continued in the area of air quality, meteorology, terrestrial ecology, aquatic ecology, soils, revegetation, and archaeology.

Air quality data for the quarter indicated that, with the exception of ozone and non-methane hydrocarbons, all parameters fell within the expected normal, low background ranges. Of these two, only non-methane hydrocarbon levels actually exceeded state/federal standards (18 times). Ozone, however, was close to the maximum allowable levels.

Several air quality parameters, CO, NO, NO_x, SO_2 and H_2S, were measured at levels very close to the lower limit of instrument sensitivity.

Particulate concentrations were lower during the winter quarter than during the two previous quarters. This decrease in particulate concentration may be related to decreased activity and snow cover.

Wind speeds were slightly higher at the two plateau sites ($\sim$ 7.0 and 8.5 mph) than they were at the valley sites ($\sim$ 5.0 and 5.5 mph). Plateau winds are predominately from the southwest; valley winds reflect terrain channeling influences.

Atmospheric stability most frequently fell into the slightly stable (51%) or neutral (37%) categories. Greatest stability was experienced during early morning hours.

Upper air studies were not conducted during the quarter.

Precipitation data indicate a winter quarter total of $\sim$ 2.2 inches, with a maximum daily total of 0.2 inches at Site 1. The maximum amount of snowfall measured was 7.0 inches. Solar radiation measured during the winter ranged from < 1 to 1.03 cal/cm^2/min.

Two separate visibility studies are conducted in the study area, utilizing two methodologies. Tract C-a visibility measurements indicated a range in visibility from 5 to 150 miles. Basin-wide visibility measurements for all views combined resulted in a visual range of from 17 to 149 miles.

Noise levels on the tract ranged from 28 to 77 dB.

No vegetation data were collected during the winter quarter. Shrub photoplot counts for the grazing exclosures were completed and filed.

One small mammal live-trapping effort was conducted during the quarter. Eighty-eight individuals were captured, 78% of which were deer mice. Weights of small mammals had decreased somewhat, and stomach analysis revealed that deer mice were eating seeds. A few lagomorphs were seen during night censusing.

Five large mammal aerial surveys were conducted during the quarter. The maximum number of mule deer sighted during any one survey was 367 on 18 December. Maximum numbers of elk, feral horses and cattle sighted during individual flights were 11, 69 and 385, respectively.

Coyotes and weasels were documented at predator scent stations during the quarter and six species of mammals were documented during winter track counts. Mule deer tracks occurred most frequently.

Avifauna studies included aerial flights, raptor ground surveys and opportunistic sightings. These studies revealed the presence of the golden eagle, common raven, saw-whet owl, great horned owl, short-eared owl, long-eared owl, sage grouse, goshawk, bald eagle, red-tailed hawk and prairie falcon.

Reptile, amphibian and invertebrate data were not collected during the quarter. No endangered species were seen.

Aquatic chemistry and biotic data for October, November and December are presented in this report.

Physical and chemical data agree well with previous quarters except for high conductivity values in Yellow Creek.

Totals of 115 phytoplankton taxa, 72 zooplankton taxa and 111 benthic taxa were identified from samples taken during the period.

Sediment chemistry analysis revealed that concentrations of herbicides are low (< 0.02 µg/g) and that concentrations of most other substances have remained relatively the same from previous quarters.

Rooted aquatic plants were scarce, occurring at only four stations in October and one station in December.

Eleven species of fishes (194 individuals) were collected during the quarter. Only two fish were game species.

Analysis of soil samples taken earlier in the study is currently being completed.

Additional analysis of archaeological material during the quarter included: cluster analysis, lithic analysis and projectile point descriptions. Additional review of the literature was also completed.

Lithic analysis supported the supposition that use of the area was primarily seasonal for hunting and gathering. Projectile point analysis revealed that the area may have been used as far back as 9,000 B.P. Cluster analysis, when supported by lithic and projectile point data, reveals that certain areas were used more extensively than others (upland areas near watercourses), and were probably campsites that were used on a seasonal basis over a number of years. Presence of site clusters make some areas worthy of further study.

Progress in the revegetation program involved plotting surface soils from study plots in the greenhouse, and the seeding, germination and transplantation of these seedlings to obtain voucher specimens to aid in identification of plant species.

2.0 ENVIRONMENTAL BASELINE DATA GATHERING PROJECT

The environmental baseline data gathering project is an on-going multidisciplinary program designed to provide information on baseline conditions for a number of environmental parameters. Studies were initiated in October 1974 in the areas of air quality, meteorology, terrestrial ecology, aquatic ecology, and archaeology. Other programs which have been initiated since then include soils, revegetation, paleontology, trace metals, seismicity and visibility. Disciplines within each of these programs are listed in Figure 2.0-1.

This report covers progress within each of these areas for the period of December 1975 through February 1976. Discussions are limited to the sixth quarter of study. For annual trends after one year of study, consult the DDP and the annual report, which became available in January 1976.

Objectives and methods for these programs were presented in the annual report and in previous progress reports; therefore, they are not repeated herein. Work on one program, seismicity, has been concluded.

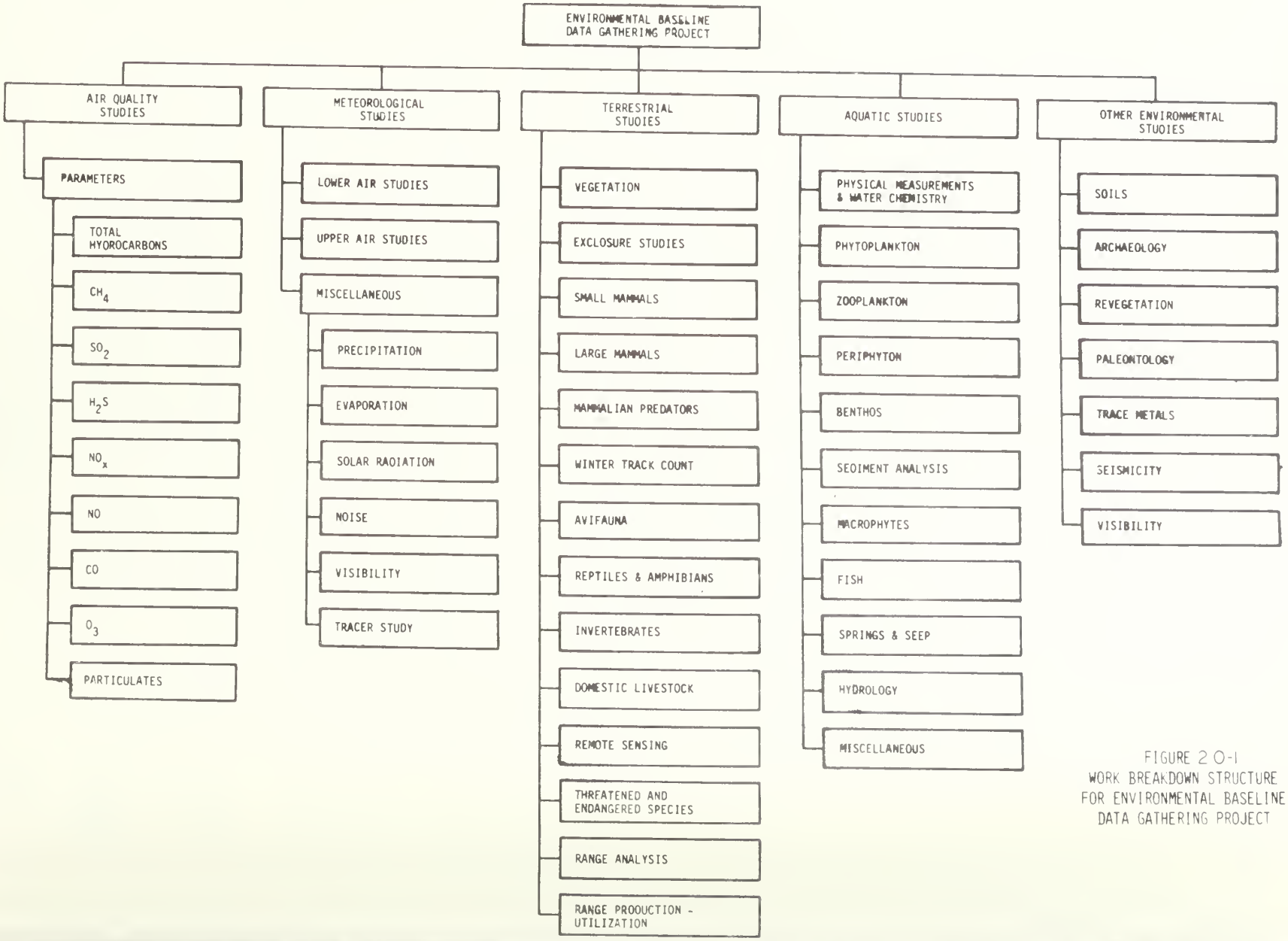


FIGURE 2.0-1
WORK BREAKDOWN STRUCTURE
FOR ENVIRONMENTAL BASELINE
DATA GATHERING PROJECT

2.1 Air Quality

Air quality studies are designed to meet and, in some cases, exceed lease stipulations.

The Air Quality and Meteorological Data Acquisition Sytem for the RBOSP consists of: four monitoring sites, each with tower-mounted meteorological instruments and trailer-contained air quality instrumentation; interface electronics; RF data telemetry links; and a central minicomputer for data storage and processing (Figure 2.1-1). Parameters measured at each site are shown below.

Site No.	THC	CH_4	SO_2	H_2S	NO_x	NO	CO	O_3	Particulates
1	X	X	X	X	X	X	X	X	X
2	X	X	X	X					X
3	X	X	X	X	X	X	X	X	X
4	X	X	X	X					X

Data from all stations are sent to the minicomputer at the central station (Site 1). The minicomputer exponentially averages the air quality data from the continuously operating analyzers. The minicomputer stores the data on magnetic tape, the primary recording medium. A high speed printer provides a hardcopy printout. Backup analog recorders are located in air quality trailers.

The Winter 1975-76 quarter (season), as used in this section, is defined as December 1, 1975 through February 29, 1976.

2.1.1 Parameters

2.1.1.1 Objectives

Air quality parameters are the same as those described in Progress Report 3-Summary. See Section 2.1.1.1 for specific objectives.

2.1.1.2 Methods

Table 2.1-1 lists the instruments and air quality measurement techniques used for monitoring gases. Also presented are the lower detectable limits (LDL) for the instruments. The LDL are interpreted as the lowest concentration that can be differentiated from noise.

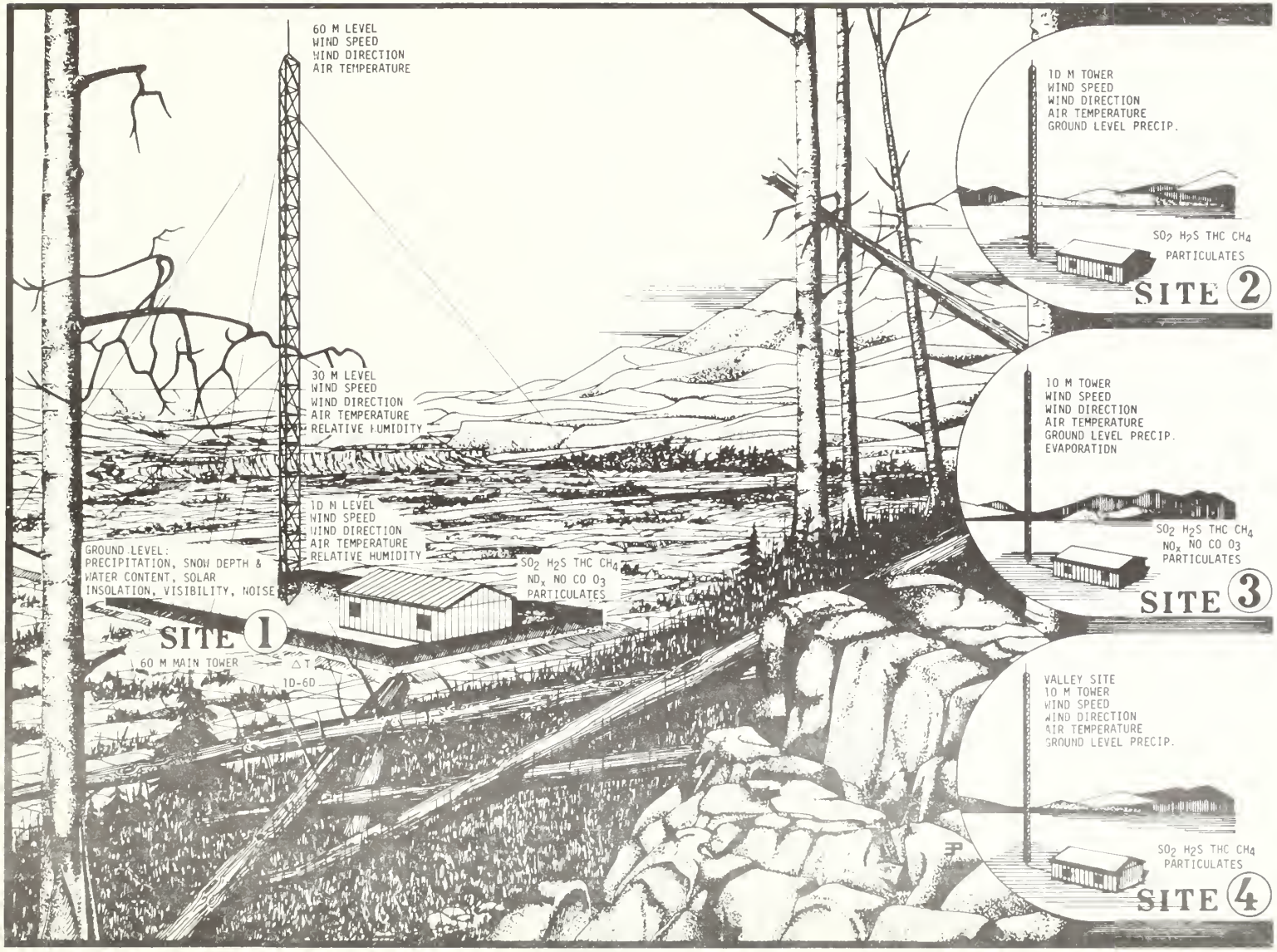


Figure 2.1-1. Meteorological and air quality data acquisition system for Tract C-a, RBOSP.

Table 2.1-1. Air quality instrumentation and measurement techniques, RBOSP.

Parameter	Manufacturer	Model	Technique	Lower Detectable Limit (ppm)	Accuracy ± (ppm)
SO_2/H_2S	Bendix	8700X	Flame photometric with separation column for SO_2 and H_2S	0.005	0.020
NO_x/NO	Bendix	8101-B	Chemiluminescence	0.005	0.010
THC/CH_4	Bendix	8201	Flame ionization detector with separation column for CH_4	0.005	0.10 (THC) 0.02 (CH_4)
Photochemical Oxidant (O_3) 1/	Bendix	8002	Chemiluminescence	0.001	0.004 2/
CO	Bendix	8501-5CA	Nondispersive infrared detector	0.5	0.500 2/

1/ Photochemical oxidant corrected for interference due to nitrogen oxide and nitrogen dioxide as measured by the Federal Reference as ozone (O_3) with the chemiluminescence method.

2/ Estimated accuracy.

Detection techniques are the same as those described in Progress Report 3-Summary. See Section 2.1.1.2 for specific methods used in the Air Quality Studies.

2.1.1.3 Results

Analysis of the air quality parameters measured on Tract C-a indicates that with the exception of ozone and hydrocarbons, the mean values are in the expected low background ranges. Results of the analysis are discussed and tabulated in this section.

Table 2.1-2 presents a comparison of federal and state standards with measurements taken from 1 December 1975 through 29 February 1976 at the RBOSP sites. The only parameter which exceeded standards this quarter was nonmethane hydrocarbon (NMHC). The number of times that these measurements exceeded standards was analyzed, taking into consideration Table 2.1-1 which presents the lower limits of detectability and the accuracies of the analyzers used. When the lower limit of detectability of an analyzer is of similar magnitude as the regulatory standard, the analyzer will, at times, indicate higher values than the standard, although the standard may not be violated.

The conclusion was reached that some of the violations of the federal nonmethane hydrocarbon standard could have been related to instrument specifications because the combination of detection limit and accuracy is similar in magnitude to the standards value. Eighteen nonmethane hydrocarbon values measured for the quarter violated the federal 3-hour maximum primary and secondary standards. This represents less than one percent of the available time in the quarter.

The particulate concentrations observed during this quarter did not violate either the federal 24-hour maximum primary and secondary standards or the state 24-hour maximum standards. Also, the mean value for all sites for the quarter, if continued at the same rate, would not result in an annual mean higher than the federal or state annual particulates standard.

Seasonal minimum, maximum, and mean values for all air quality parameters for Winter 1975-76 are presented in Table 2.1-3.

The seasonal mean values for CO, NO, NO_x, H_2S, and SO_2 shown in Table 2.1-3 are similar in value to the lower limit of detectability of the analyzers. Levels of nonmethane hydrocarbons and ozone are similar in magnitude to the maximum levels specified by the regulatory standards. The levels of these compounds appear to be background and not associated with man's activity. The hydrocarbon (both methane and nonmethane) concentrations remain relatively constant throughout the day, while the ozone exhibits definite diurnal variations with a maximum at about noon and a minimum at about midnight. Intersite comparisons between the same parameters show good agreement.

Table 2.1-2. Comparison of Federal and State air quality standards to measurements made during Winter 1975-76, RBOSP.

Parameter	Standard µg/m³	Standard ppm	Time Interval	Type of Standard	No. of Times Exceeded During Quarter	Site 1 Max. Measured Value µg/m³	Site 1 Max. Measured Value ppm	Site 1 Time	Site 2 Max. Measured Value µg/m³	Site 2 Max. Measured Value ppm	Site 2 Time	Site 3 Max. Measured Value µg/m³	Site 3 Max. Measured Value ppm	Site 3 Time	Site 4 Max. Measured Value µg/m³	Site 4 Max. Measured Value ppm	Site 4 Time
CO	40,000	35	1 hr max.	Primary and Secondary[1/]	0	1160	0.998	1700 2/1	___	___	___	4012	3.453	1700 12/30	___	___	___
CO	10,000	9	8 hr max.	Primary and Secondary[1/]	0	1092	0.940	0400 12/6	___	___	___	2677	2.304	0000 12/31	___	___	___
Nonmethane Hydrocarbon	160	0.24	3 hr max. (6-9 am only)	Primary and Secondary[1/]	18	255	0.384	2/1	154	0.232	12/1	160	0.240	1/24	200	0.301	1/24
NO_2	100	0.05	Annual Arith. Mean	Primary and Secondary[1/]	NA	0[3/]	0.000[3/]	NA	___	___	___	0[3/]	0.000[3/]	NA	___	___	___
Ozone	160	0.08	1 hr max.	Primary and Secondary[1/]	0	82	0.041	1700 2/27	___	___	___	88	0.044	1500 2/27	___	___	___
SO_2	365	0.14	24 hr max.	Primary[1/]	0	8	0.003	1400 2/5	10	0.004	2000 2/20	8	0.003	1400 2/5	29	0.011	1900 2/20
SO_2	80	0.03	Annual Arith. Mean	Primary[1/]	NA	5[3/]	0.002[3/]	NA	10[3/]	0.004[3/]	NA	3[3/]	0.001[3/]	NA	29[3/]	0.011[3/]	NA
SO_2	1300	0.5	3 hr max.	Secondary[1/]	0	21	0.008	1900 12/4	21	0.008	2300 2/19	8	0.003	1900 1/27	96	0.037	2300 2/19
Particulates	260		24 hr max.	Primary[1/]	0	38	NA	2/19	23	NA	2/19	26	NA	2/4	22	NA	2/4
Particulates	75		Annual Geo. Mean	Primary[1/]	NA	2[4/]	NA	NA	2[4/]	NA	NA	5[4/]	NA	NA	3[4/]	NA	NA
Particulates	150		24 hr max.	Secondary[1/]	0	38	NA	2/19	23	NA	2/19	26	NA	2/4	22	NA	2/4
Particulates	60		Annual Geo. Mean	Secondary[1/]	NA	2[4/]	NA	NA	2[4/]	NA	NA	5[4/]	NA	NA	3[4/]	NA	NA
Particulates	150[7/]		24 hr max.	State[2/]	0	29	NA	2/19	18	NA	2/19	20	NA	2/4	17	NA	2/4
Particulates	45[7/]		Annual Arith. Mean	State[2/]	NA	3[3/]	NA	NA	3[3/]	NA	NA	5[3/]	NA	NA	3[3/]	NA	NA

Table 2.1-2. Continued

1/ Environmental Protection Agency Regulations on national primary and secondary ambient air quality standards (40 CFR 50; 36 FR 22384, November 25, 1971; as amended by 38 FR 25678, September 14, 1973; 40 FR 7042, February 18, 1975).
2/ Ambient air standards for metropolitan Denver air quality control region, air quality control areas, and the State of Colorado; Adopted: September 10, 1970, Effective: December 17, 1970.
3/ Arithmetic mean of values measured during the quarter.
4/ Geometric mean of values measured during the quarter.
5/ All EPA standards are at reference conditions of 25
6/ Reference conditions of
7/ Measured at ambient temperature and pressure.
NA = Not Applicable.
____ = Not measured at this site.

Table 2.1-3. Air quality parameters, seasonal summary for Winter 1975-76, RBOSP 1/

Parameter	Units	Minimum	Maximum	Arithmetic Mean
		SITE 1		
O_3	ppm	0.014	0.041	0.032
CO	ppm	0.000	0.998	0.359
NO	ppm	0.000	0.066	0.008
NO_x	ppm	0.000	0.062	0.006
CH_4	ppm	0.880	1.631	1.352
THC	ppm	1.156	2.422	1.488
H_2S	ppm	0.001	0.009	0.001
SO_2	ppm	0.001	0.017	0.002
Particulates	$\mu g/m^3$	<1	38	2 2/
		SITE 2		
CH_4	ppm	1.034	1.709	1.411
THC	ppm	1.286	2.367	1.573
H_2S	ppm	0.001	0.034	0.003
SO_2	ppm	0.000	0.041	0.004
Particulates	$\mu g/m^3$	<1	23	2 2/
		SITE 3		
O_3	ppm	0.009	0.044	0.028
CO	ppm	0.000	3.453	0.945
NO	ppm	0.000	0.013	0.005
NO_x	ppm	0.000	0.011	0.005
CH_4	ppm	1.284	1.609	1.434
THC	ppm	1.347	1.950	1.528
H_2S	ppm	0.000	0.009	0.003
SO_2	ppm	0.000	0.005	0.001
Particulates	$\mu g/m^3$	<1	26	4 2/
		SITE 4		
CH_4	ppm	1.007	1.902	1.376
THC	ppm	1.054	2.343	1.456
H_2S	ppm	0.001	0.065	0.011
SO_2	ppm	0.002	0.060	0.011
Particulates	$\mu g/m^3$	<1	12	3 2/

1/ Concentrations are based upon hourly average data base except particulates which are 24 hour sample values.

2/ Geometric mean of the 24 hour composite samples for the quarter, values of <1 are used in the mean computation as 0.5.

Table 2.1-4 gives the particulate concentration for the quarter for each site. The large variation between samples and sites is expected because of considerable fugitive dust caused by activities on site and dust from the road. For example, Site 3 is not far from a well-traveled road, which may be the source of the relatively higher values obtained there.

Particle size data by concentration and particle size range are given in Table 2.1-5. These data show that a large portion of the particulate weight is made up of particles of 0 to 0.95 μm. The values indicated by less than 1 $\mu g/m^3$ are less than the estimated concentration measurable by the measurement technique.

The results of particle trace-element analysis on a particulate sample taken during the quarter are given in Table 2.1-6.

Table 2.1-4. Particulate concentration data for Winter 1975-76, values are presented in $\mu g/m^3$, RBOSP.

Month	Day	Year	Site 1	Site 2	Site 3	Site 4
December	3	1975	< 1	2	3	4
	6		5	7	6	6
	9		10	< 1	4	3
	12		4	11	14	12
	15		4	3	9	5
	18		1	1	3	3
	21		< 1	< 1	2	4
	24		4	1	5	5
	27		5	4	12	4
	30		4	1	7	2
January	2	1976	3	5	4	3
	5		< 1	2	6	5
	8		2	2	3	3
	11		2	5	5	3
	14		< 1	4	3	2
	17		< 1	1	< 1	< 1
	20		2	1	3	< 1
	23		3	3	6	3
	26		2	6	6	7
	29		2	< 1	2	1
February	1	1976	2	2	2	1
	4		2	12	26	22
	7		1	1	3	3
	10		< 1	< 1	3	1
	13		2	3	2	2
	16		4	4	8	3
	19		38	23	11	9
	22		2	< 1	1	< 1
	25		12	5	7	5
	28		10	5	15	9

Table 2.1-5. Particulate concentration by equivalent aerodynamic diameter[1/] for Winter 1975-76, RBOSP.

Size Range (microns)	12/9	12/21	1/2	1/14	1/26	2/7	2/22
7.2 - ∞	1.28	<1	<1	<1	<1	<1	<1
3.0 - 7.2	1.47	<1	<1	<1	<1	<1	<1
1.5 - 3.0	1.53	<1	<1	<1	<1	<1	<1
0.95 - 1.5	1.41	<1	<1	<1	<1	<1	<1
0 - 0.95	3.92	<1	3	<1	2	1	2

1/"Equivalent Aerodynamic Diameter" is defined as the size of a spherical particle of density 1 gm/cc, which has the same terminal settling velocity as the sampled particle.

Table 2.1-6. High volume filter, analytical trace element results for Winter 1975-76, RBOSP

Parameter	Concentration (ng/cm^2)	Parameter	Concentration (ng/cm^2)	Parameter	Concentration (ng/cm^2)	Parameter	Concentration (ng/cm^2)
Uranium	0.11	Terbium	<0.01	Ruthenium	<0.01	Vanadium	5.8
Thorium	0.25	Gadolinium	<0.01	Molybdenum	0.73	Titanium	42
Bismuth	0.12	Europium	<0.01	Niobium	0.45	Scandium	<0.01
Lead	9.5	Samarium	<0.01	Zirconium	0.96	Calcium	770
Thallium	<0.01	Neodymium	<0.01	Yttrium	0.18	Potassium	450
Mercury	0.3	Praseodymium	<0.01	Strontium	3.5	Chlorine	31
Gold	<0.01	Cerium	0.39	Rubidium	0.57	Sulphur	160
Platinum	<0.01	Lanthanum	0.54	Bromine	0.79	Phosphorus	130
Iridium	<0.01	Barium	6.4	Selenium	0.21	Silicon	Maj
Osmium	<0.01	Cesium	<0.01	Arsenic	2.4	Aluminum	Maj
Rhenium	Internal Standard	Iodine	<0.01	Germanium	<0.01	Magnesium	230
Tungsten	<0.01	Tellurium	<0.01	Gallium	<0.01	Sodium	290
Tantalum	<0.01	Antimony	0.27	Zinc	58	Fluorine	71
Hafnium	<0.01	Tin	0.86	Copper	170	Oxygen	NR
Lutecium	<0.01	Indium	Internal Standard	Nickel	5.8	Nitrogen	NR
Ytterbium	<0.01	Cadmium	<0.01	Cobalt	0.22	Carbon	NR
Thullium	<0.01	Silver	<0.01	Iron	Maj	Boron	NR
Erbium	<0.01	Palladium	<0.01	Manganese	6.7	Beryllium	<0.01
Holmium	<0.01	Rhodium	<0.01	Chromium	6.7	Lithium	1.0
Dysprosium	<0.01						

NR - Not Reported
Maj - Major (outside the limits of method, greater than value not defined)

2.2 Meteorology

The meteorological studies are designed to at least meet and, in some cases, exceed environmental lease stipulations.

The RBOSP meteorological data acquisition system is integrated into the network described in Section 2.1. It includes instrument towers at Sites 1, 2, 3, and 4. Data transmission from the remote sites and recording methods are similar to those utilized in the air quality studies, i.e., hard copy reports are provided hourly, and continuous analog records are made for each parameter.

The central station is located at Site 1, which has a 60-m meteorological tower. Wind speed, wind direction, air temperature and relative humidity are measured at the 10-m level. Ambient temperature, wind speed, and wind direction are measured at the 30- and 60-m levels, and the temperature differences between the 10- and 60-m levels are recorded. Additionally, precipitation and solar radiation are monitored at ground level at Site 1.

All meteorological parameters are measured continuously. The data are averaged during the last 15 minutes of each hour and entered into the computer file.

The following parameters are not part of the automatic data acquisition system, but are monitored routinely or seasonally at Site 1:

- Evaporation rate
- Snow depth and water content
- Particulates
- Visibility

At each of remote sites 2, 3, and 4 there is a 10-m meteorological tower. Wind speed, wind direction, and ambient air temperature are measured at the 10-m level.

A seasonal upper air study measuring winds and temperatures to an elevation of 13,000 feet about MSL is scheduled over Tract C-a for five quarters of the program. These studies, performed by manually tracking pilot balloons with a theodolite and aircraft-mounted temperature sensors, provide basic information on the mean mixing layer height above Tract C-a. No upper air studies were conducted during the current quarter.

Tracer diffusion studies designed to track dispersion of the tracer material in the lower atmosphere to evalute modeling predictions and lead to a better understanding of terrain effects will be conducted. The first season of ambient noise level measurements were completed in this quarter.

All the data obtained are used to define the baseline atmospheric conditions and for application in the appropriate diffusion models used to predict the effects of shale oil operations on ambient air quality.

The baseline meteorological program is established at two lower atmospheric levels, referred to in this report as lower air studies and upper air studies. The lower air studies include data obtained at the four station networks; the upper air studies involve obtaining data on the winds aloft and vertical temperature profiles. Upper air studies are performed on a seasonal basis. Tracer studies are performed during the baseline study period concurrently with upper air wind and temperature samplings. Studies which provide useful information, but do not fall into these categories are: precipitation, evaporation, solar radiation, noise, and visibility (discussed under Miscellaneous, Section 2.2.3).

The Winter 1975-76 quarter (season), as used in this section is defined as December 1, 1975 through February 29, 1976.

2.2.1 Lower Air Studies

Lower air studies refer to the meteorological data acquired from the four station ground networks and include wind speed, direction, and air temperature at 10-m above the surface at all four monitoring sites. Relative humidity at 10-m, and wind speed, wind direction, and air temperature at 30- and 60-m above the surface at the main monitoring site are also included.

2.2.1.1 Objectives

No change has occurred since Progress Report 5-Summary. See Section 2.2.1.1 in Progress Report 4-Summary for specific objectives of the meteorological lower air studies.

2.2.1.2 Methods

No change has occurred since Progress Report 5-Summary. See Section 2.2.1.2 in Progress Report 2-Summary for specific methods used in the meteorological lower air studies.

2.2.1.3 Results

The 1975-76 winter season summaries of the minimum, maximum, and mean values of the meteorological parameters measured at each site are presented in Table 2.2-1. The composite hour, as illustrated in Figures 2.2-1 through 2.2-6, is the mean of the data taken during a particular hour of the day for all days of the period indicated. A composite day defines the minimum, maximum, and mean values for 24 composite hours of a month. The minimum and maximum listed are the individual hourly averages which are greater than or less than all other hourly averages.

Wind at Sites 1 and 2 (10-m level) were predominantly from the southwest during Winter 1975-76. The mean wind speeds were 6.96 and 8.44 mph, respectively. Although Sites 1 and 2 are at about the same elevation (7,400 feet above MSL); the local terrain at Site 2 is relatively flatter than at Site 1. The Site 2 monitoring location is the highest point within a radius of approximately 1 km. The 10-m level of the main meteorological tower at Site 1 is approximately 50 m lower than the elevation of several knolls within several hundred meters. The increased terrain influence at Site 1 is probably responsible for the lower mean wind speed.

Table 2.2-1. Meteorological parameters, seasonal summary for Winter 1975-76, RBOSP.

Parameter	Units	Minimum	Maximum	Mean
	SITE 1			
Wind Speed (10 m)	mph	0.59	32.31	6.96
Wind Speed (30 m)	mph	0.58	34.98	8.03
Wind Speed (60 m)	mph	0.56	37.87	9.79
Wind Direction Sigma (10 m)	degrees	0.88	33.27	11.20
Air Temperature (10 m)	C	-21.10	8.03	-2.20
Air Temperature (30 m)	C	-22.10	8.07	-2.51
Temperature Difference (60 to 10 m)	C	-4.79	3.38	-0.02
Relative Humidity (10 m)	%	16.34	92.43	36.72
	SITE 2			
Wind Speed (10 m)	mph	0.56	34.68	8.44
Air Temperature (10 m)	C	-21.40	8.57	-2.40
	SITE 3			
Wind Speed (10 m)	mph	0.51	25.87	5.54
Air Temperature (10 m)	C	-28.20	11.15	-4.35
	SITE 4			
Wind Speed (10 m)	mph	0.50	27.47	4.93
Air Temperature (10 m)	C	-33.30	12.19	-5.30

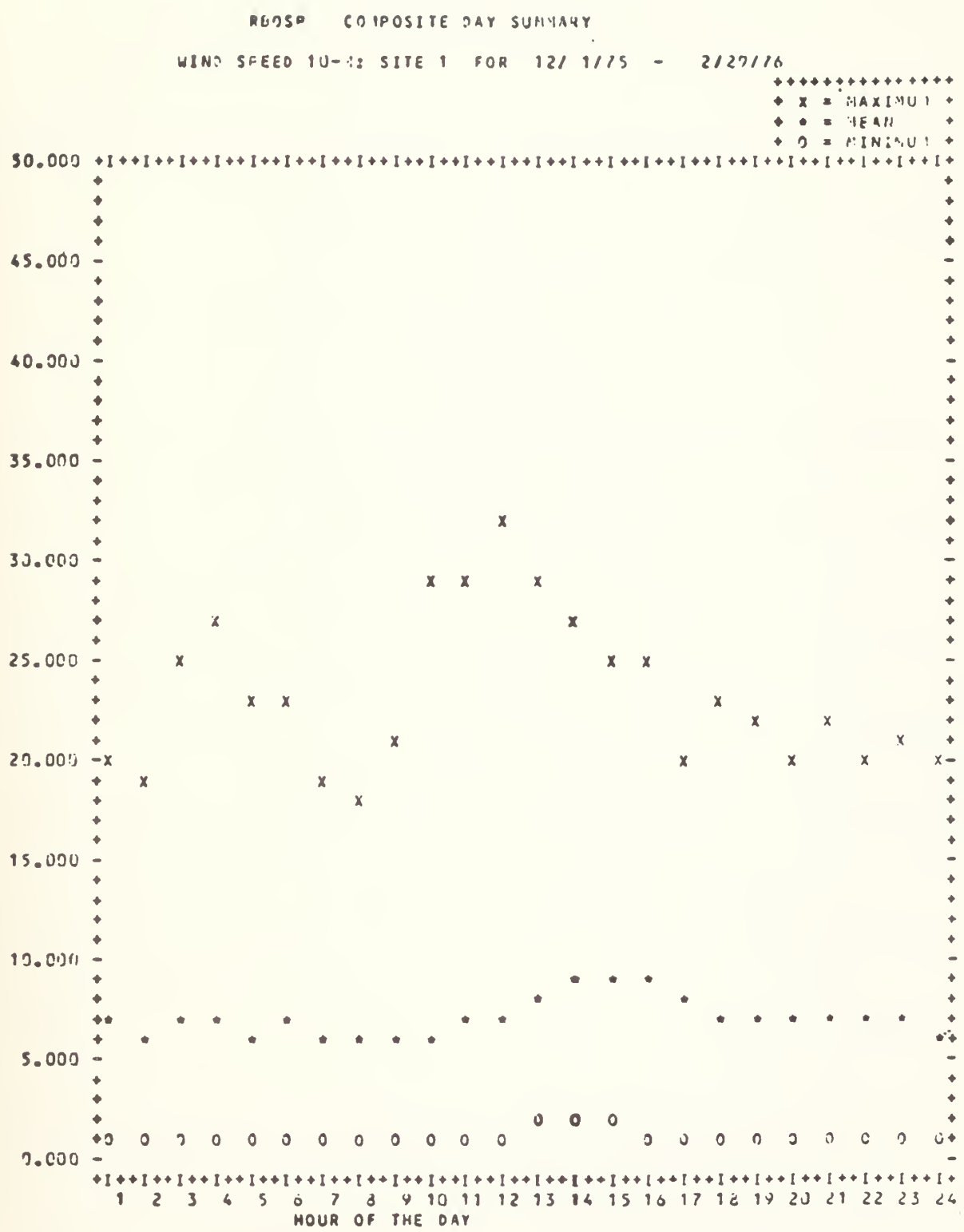


Figure 2.2-1. Wind speed, 10-m level (minimum, maximum, and mean by hour of the day) for Winter 1975-76 at Site 1, RBOSP.

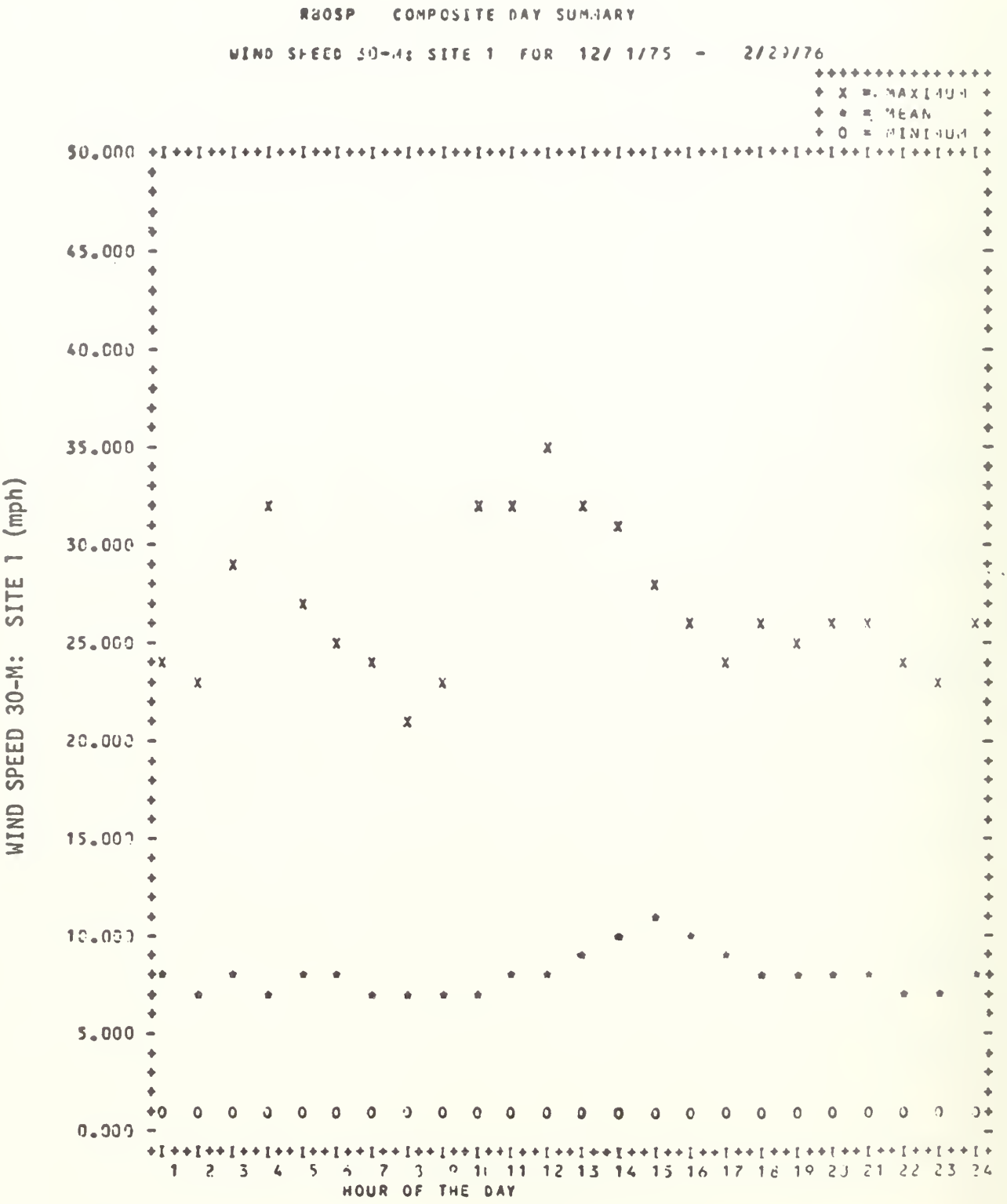


Figure 2.2-2. Wind speed, 30-m level (minimum, maximum, and mean by hour of the day) for Winter 1975-76 at Site 1, RBOSP.

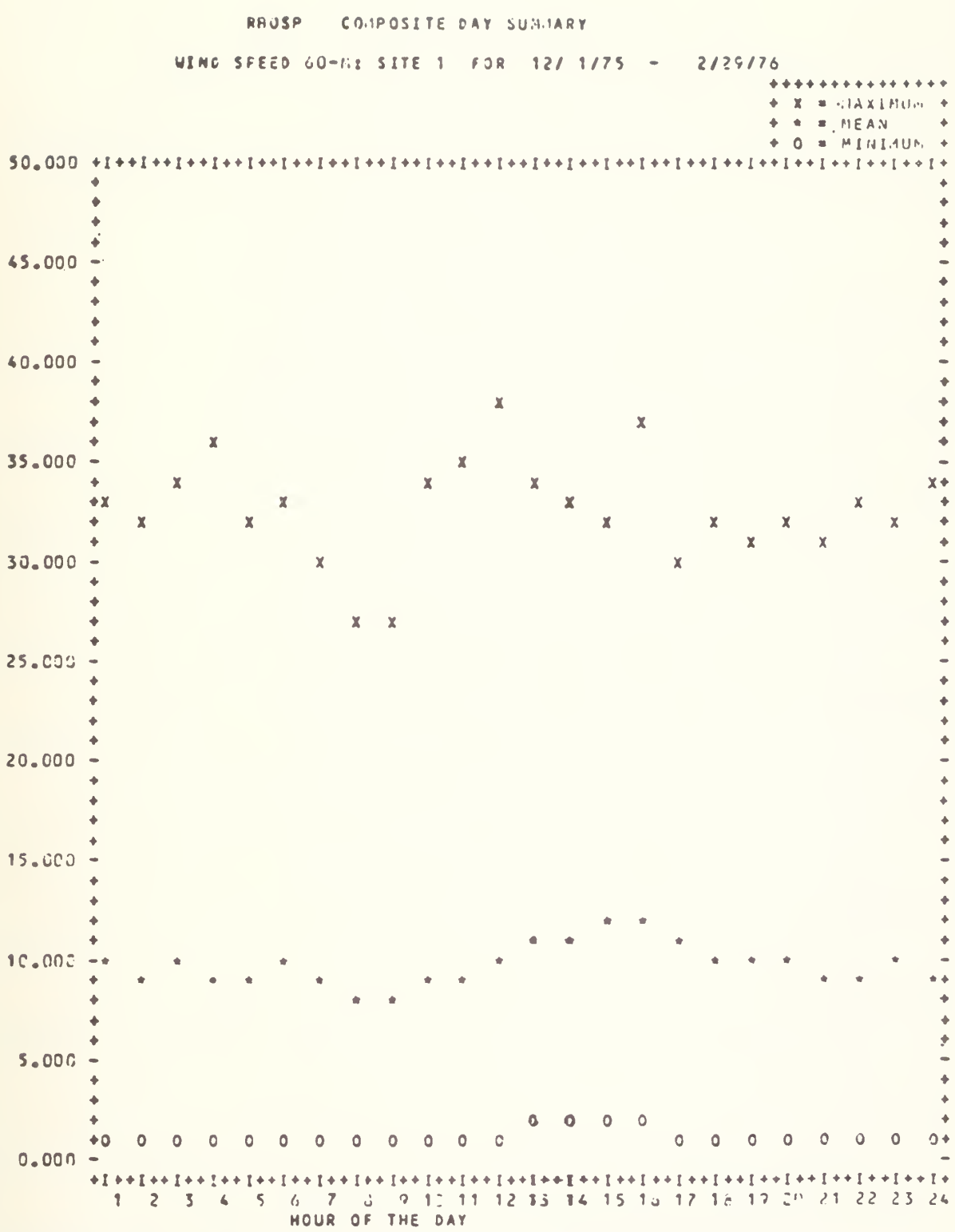


Figure 2.2-3. Wind speed, 60-m level (minimum, maximum, and mean by hour of the day) for Winter 1975-76 at Site 1, RBOSP.

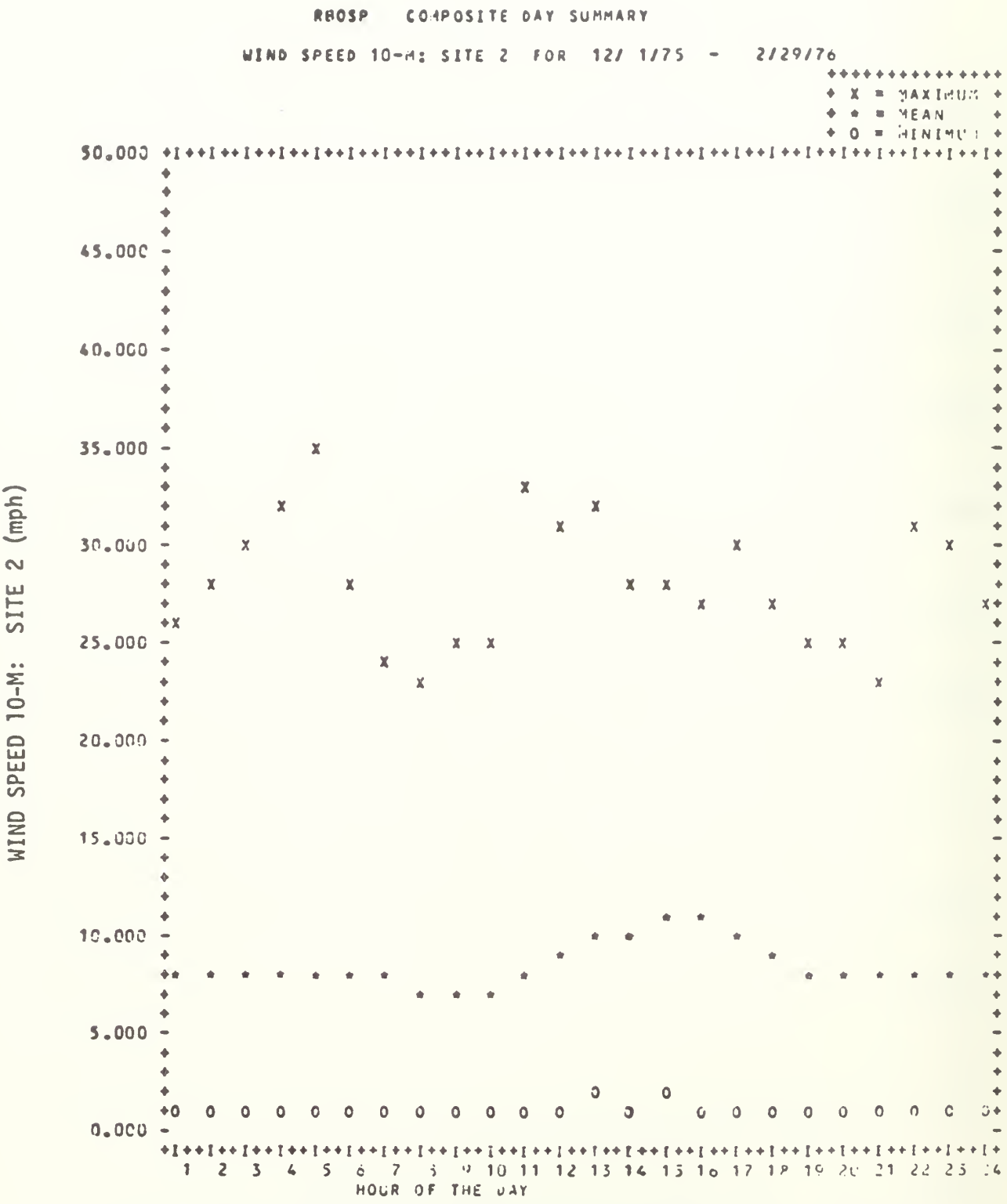


Figure 2.2-4. Wind speed, 10-m level (minimum, maximum, and mean by hour of the day) for Winter 1975-76 at Site 2, RBOSP.

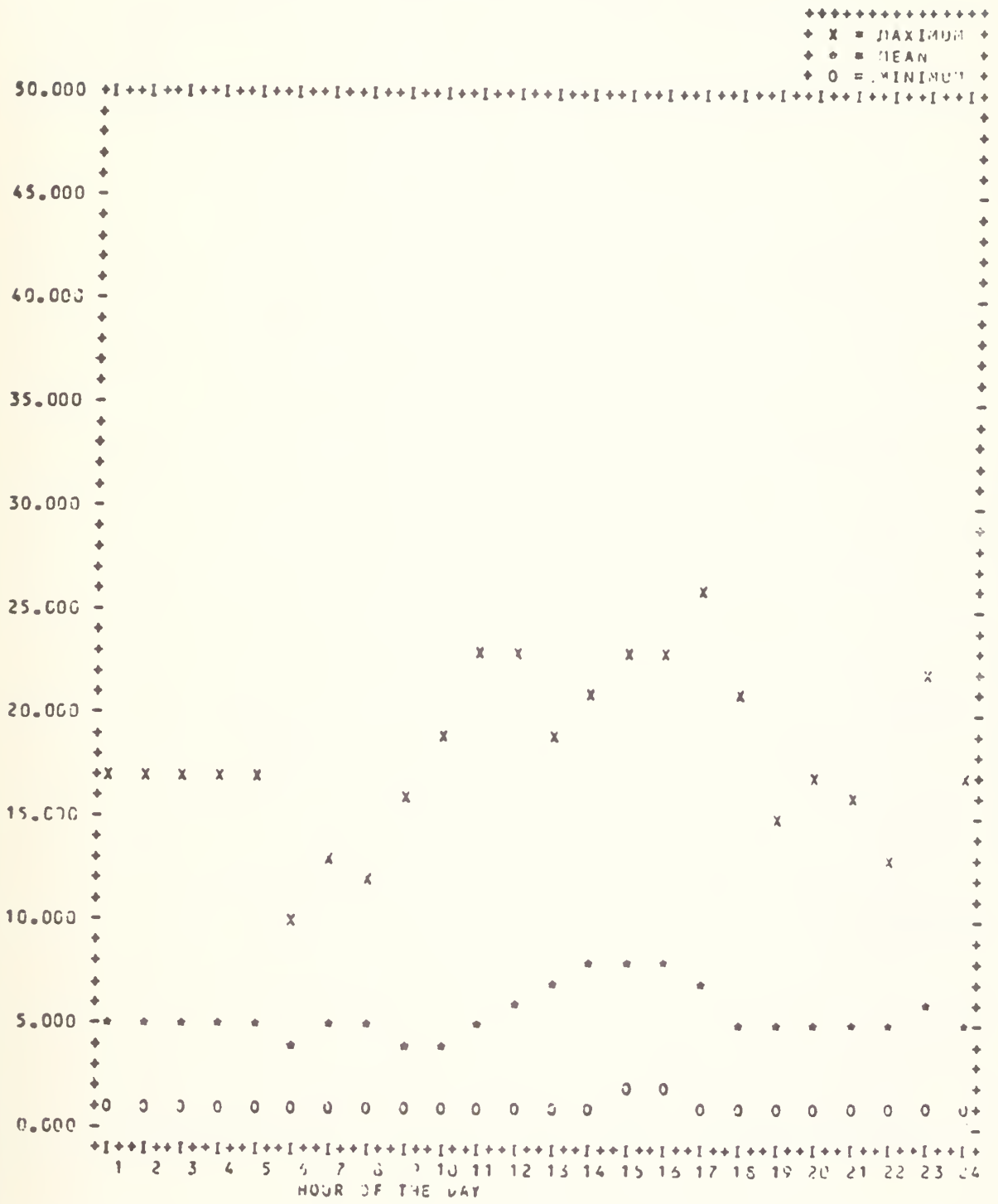


Figure 2.2-5. Wind speed, 10-m level (minimum, maximum, and mean by hour of the day) for Winter 1975-76 at Site 3, RBOSP.

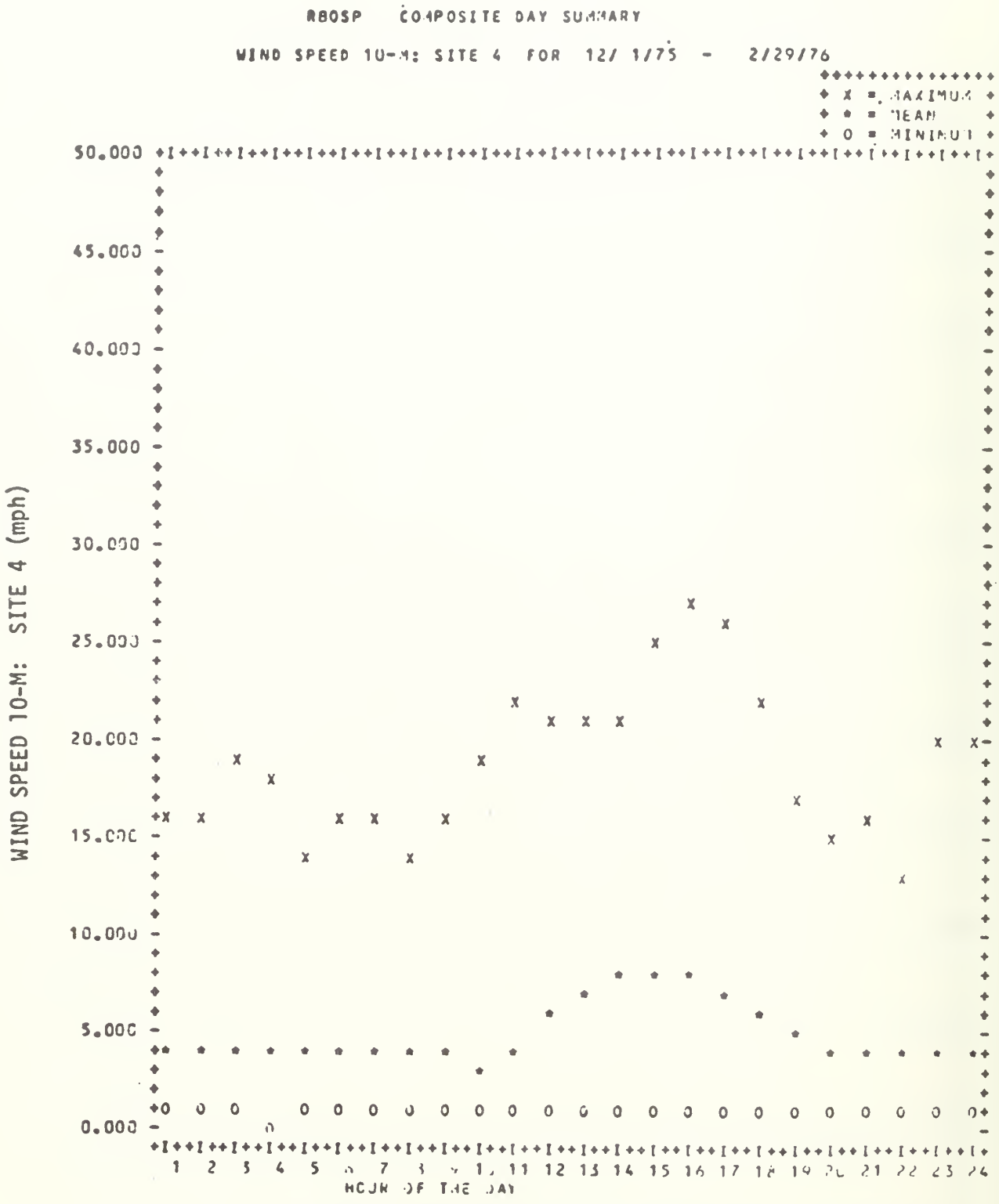


Figure 2.2-6. Wind speed, 10-m level (minimum, maximum, and mean by hour of the day) for Winter 1975-76 at Site 4, RBOSP.

Mean wind speeds at Sites 3 and 4 for the Winter 1975-76 period were 5.54 and 4.93 mph, respectively. Sites 3 and 4, below plateau levels, are situated in the approximate centers of Corral Gulch and Yellow Creek Gulch at elevations of 6,570 and 6,280 feet above MSL. Corral Gulch is oriented in a west to east direction. Yellow Creek Gulch is oriented in a south-southwest to north-northwest direction.

The diurnal variation of mean wind speed is shown in Figures 2.2-1 to 2.2-6 for each site. Mean wind speeds average 4 to 5 mph higher during daytime hours than nighttime hours with Site 1 showing the smaller variation. The 60-m level has about a 4-mph higher wind speed during the day than at night. During this quarter there was a single peak for the 60-m mean wind speed, at about 1500 hours.

The diurnal variation of the wind direction sigma at the 10-m level Site 1 is shown in Figure 2.2-7. Several maximum peaks occurred in the composite day.

Wind rose data for Winter 1975-76 are presented for all four monitoring stations in Figures 2.2-8 through 2.2-11. The percent of occurrence of each wind class can be obtained from the number scale on each wind rose plot.

Wind rose data (10-m level) from Sites 1 and 2 are comparable. The reduced frequency of occurrence of southwest winds relative to south-southwest and west-southwest winds is probably caused by the influence from a small knoll about 200-m southwest of Site 1. Extreme terrain-induced wind channeling effects exist at Sites 3 and 4. Winds at Site 3 are predominantly from the west, which is in agreement with the westerly course of Corral Gulch. The predominant winds at Site 4 are from the southwest, corresponding closely to the orientation of Stake Springs Draw and Yellow Creek. In addition to the terrain-induced channeling of the gradient winds at Sites 3 and 4, valley drainage flows contribute significantly to the direction of winds.

The term gradient wind is used here to describe wind flows resulting from a pressure difference between two points at the same elevation, while the term valley drainage flow is used to describe the winds resulting from radiative cooling of the rear surface layers of air which produces a subsiding, down-slope flow.

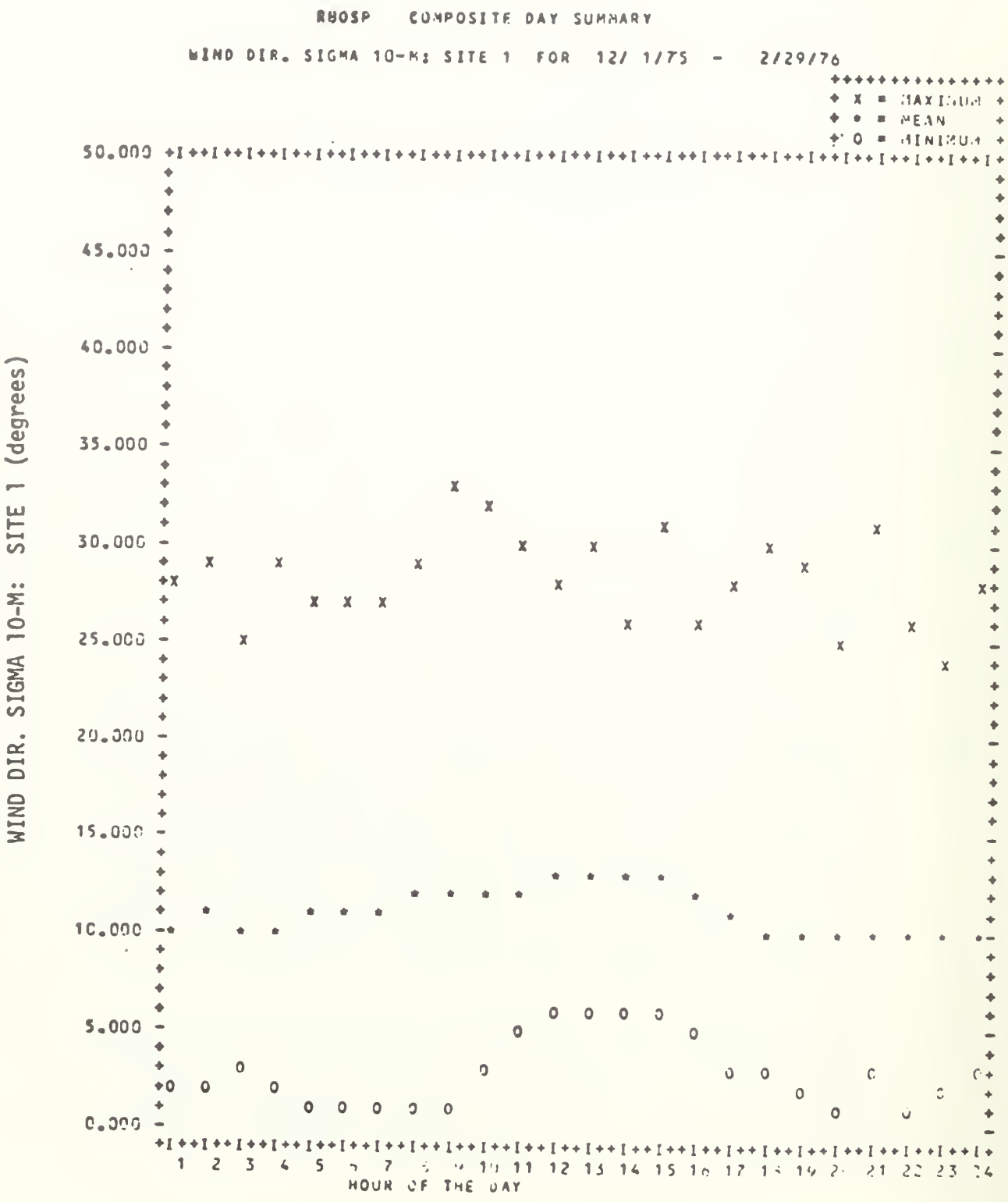


Figure 2.2-7. Wind direction sigma, 10-m level (minimum, maximum, and mean by hour of the day) for Winter 1975-76 at Site 1, RBOSP.

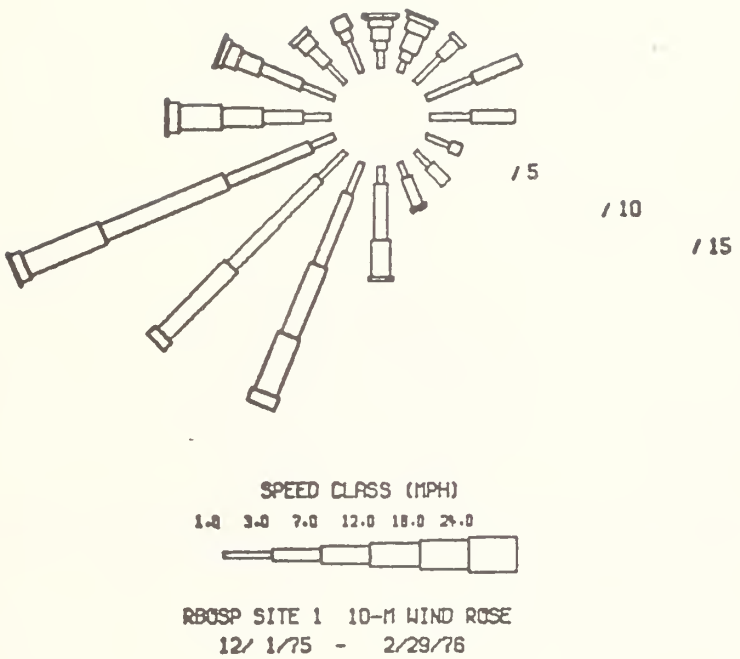


Figure 2.2-8. Winter 1975-76 wind rose from the 10-m level at Site 1, RBOSP.

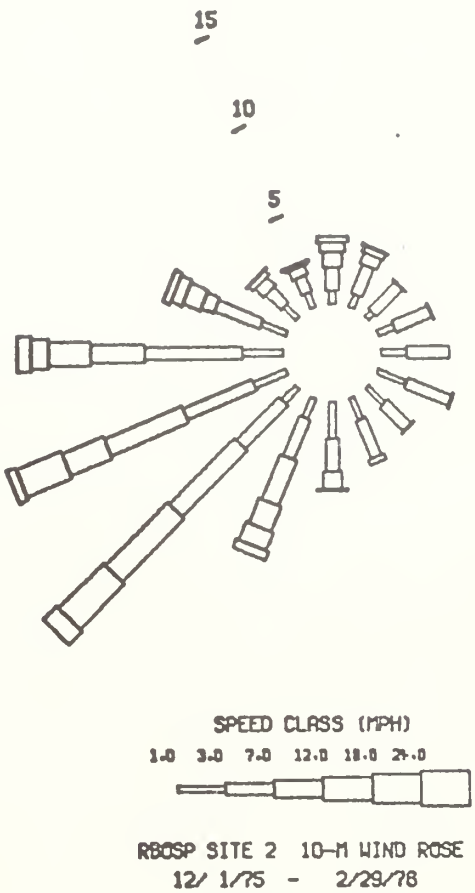


Figure 2.2-9. Winter 1975-76 wind rose from the 10-m level at Site 2, RBOSP.

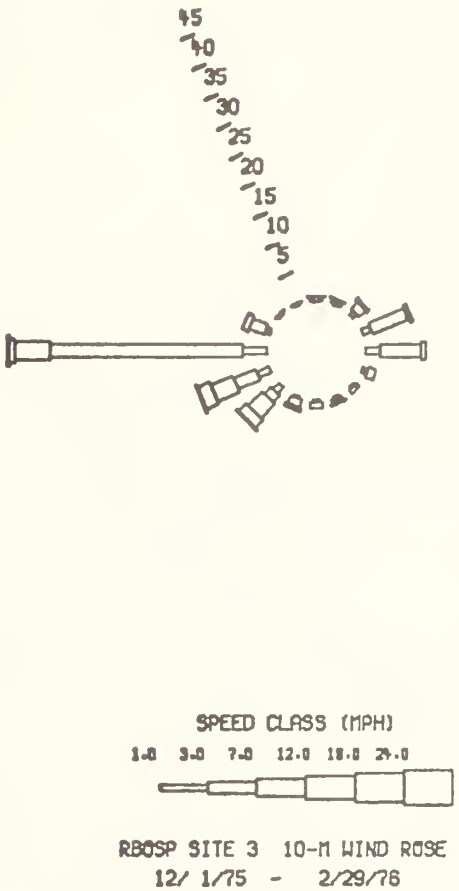


Figure 2.2-10. Winter 1975-76 wind rose from the 10-m level at Site 3, RBOSP.

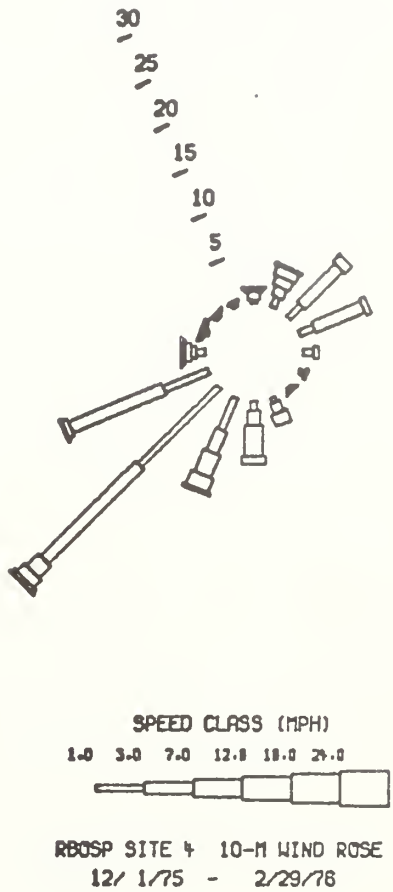


Figure 2.2-11. Winter 1975-76 wind rose from the 10-m level at Site 4, RBOSP.

A least squares fit to the mean seasonal wind speed as a function of height at the 60-m tower (Site 1) was done to investigate the applicability of the logarithmic wind profiles:

$$\bar{u} = \frac{u^*}{K} \ln \left(\frac{Z}{Z_o}\right)$$

where Z_o is the roughness parameter, K is the von Karman constant, and u* is the friction velocity. The seasonal data fit the logarithmic wind profile to a high degree of confidence (coefficient of determination = $r^2 = 0.93$) with $u^*/K = 1.52$ mph and $Z_o = 11.5$ cm. Z = height above ground (in meters).

The minimum, maximum, and mean values of air temperature for each of the four sites and temperature difference at Site 1 as a function of the hour of the day for the winter season are plotted in Figures 2.2-12 through 2.2-17.

The valley sites (3 and 4) have a much larger diurnal temperature variation than the plateau sites (1 and 2). The intensity of the cold portion of the composite days at Sites 3 and 4, in relation to that at Sites 1 and 2, is much greater. This is the result of valley drainage flows of cold air. The composite day air temperature data for Sites 3 and 4 indicate that more cold air accumulates at Site 4 than at Site 3. The elevation difference (200 ft) and the Stake Spring Draw air flow, as well as the Corral Gulch air flow draining into the Yellow Creek Gulch, contribute to this intensity difference.

Although there is a substantial difference in the diurnal variation among all sites, the average temperatures over the season agree well between sites.

Atmospheric stability conditions were determined from temperature difference measurements made between the 10-m and the 60-m level on the main meteorological tower at Site 1. Figure 2.2-17 presents the minimum, maximum, and mean composite day temperature differences as a function of the time of day for the fall season 1975-76. The data indicate that the mean surface inversion is relatively weak (about a -0.2 to -0.4 C difference in temperature) during the interval from 2000 hours MST in the evening until 0800 hours MST the following morning. When the break-up of the mean surface inversion occurs, atmospheric stability becomes significantly unstable. The intensities of the most stable inversions are more intense than those of the most unstable conditions.

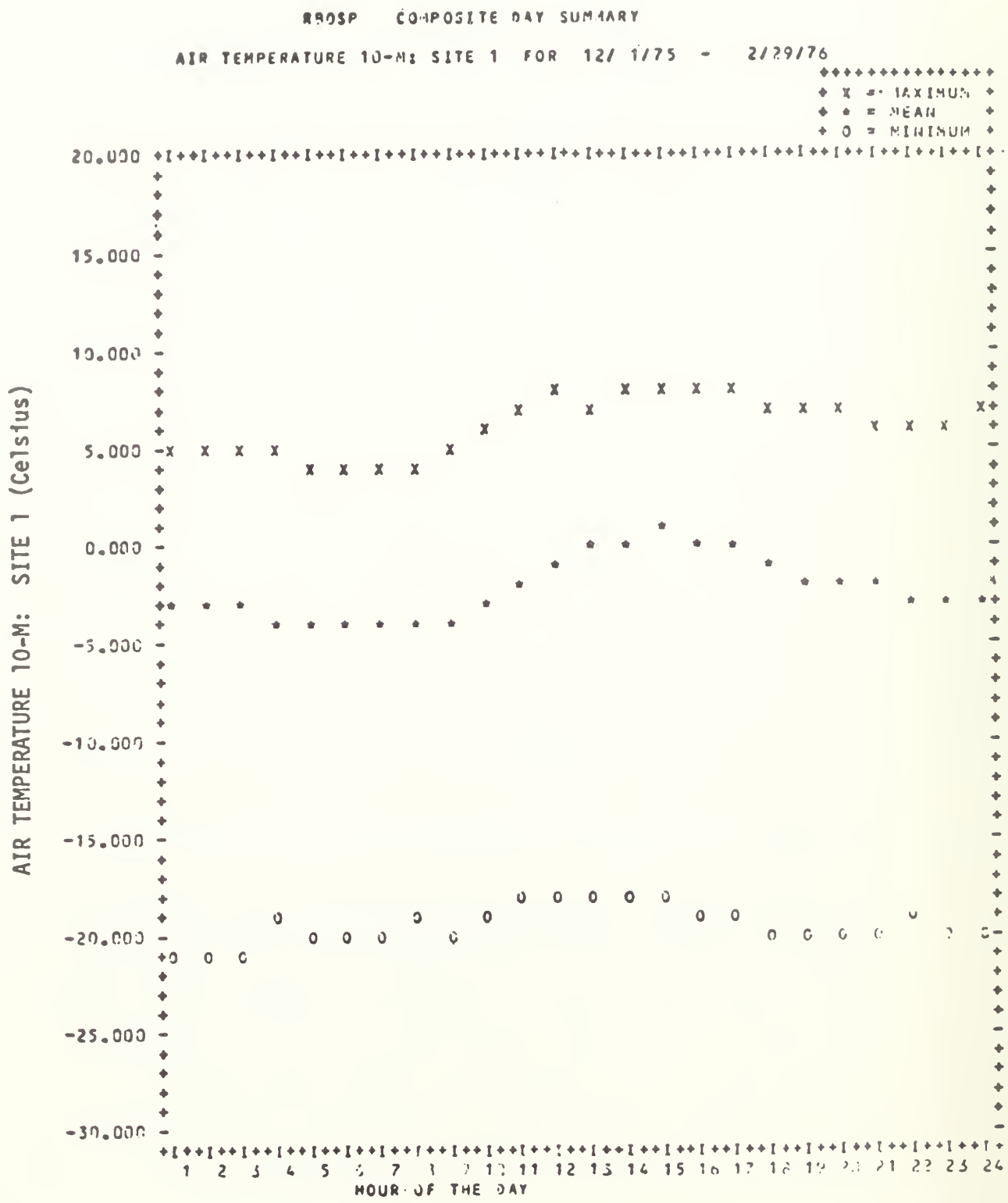


Figure 2.2-12. Air temperature, 10-m level (minimum, maximum, and mean by hour of the day) for Winter 1975-76 at Site 1, RBOSP.

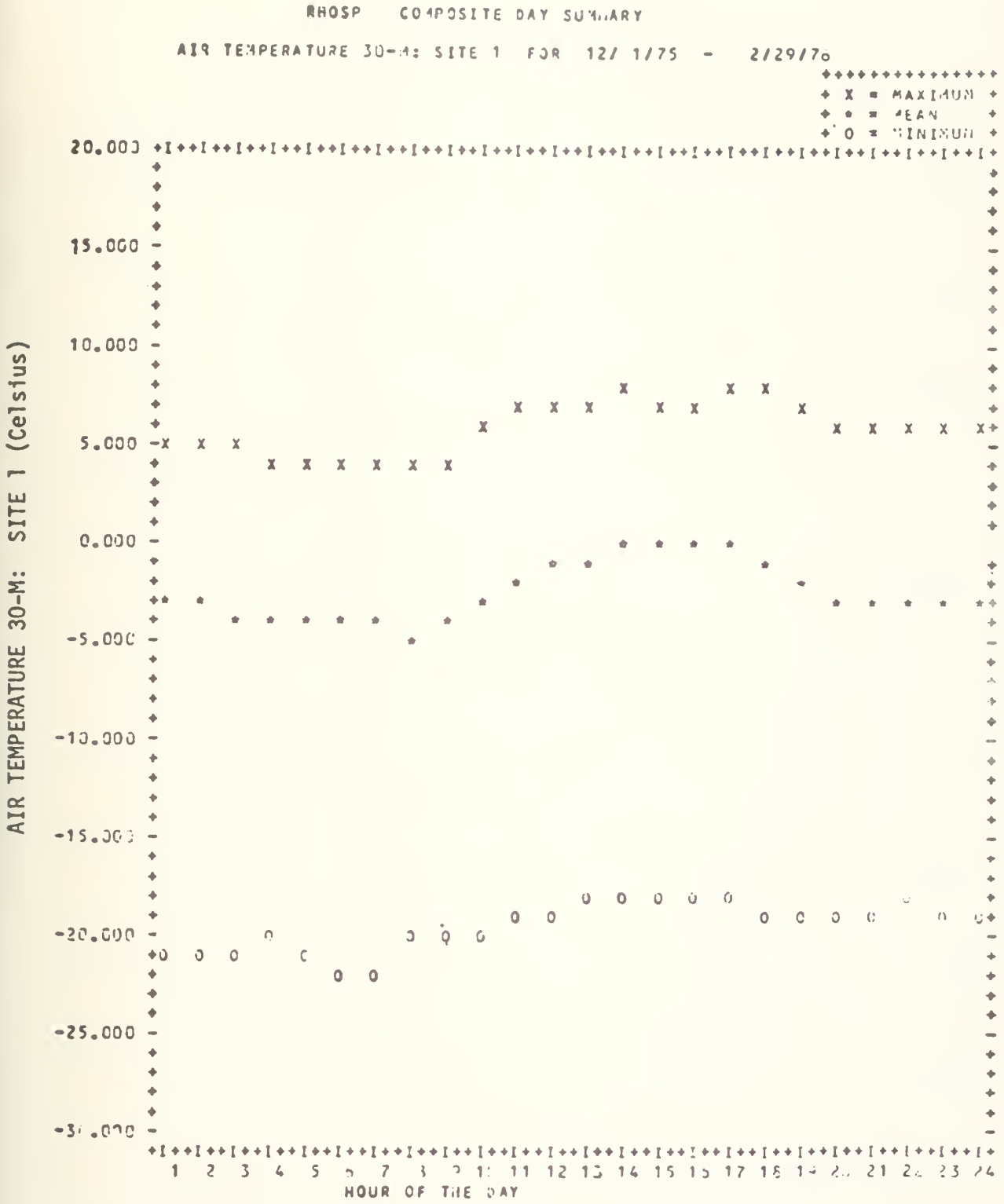


Figure 2.2-13. Air temperature, 30-m level (minimum, maximum, and mean by hour of the day) for Winter 1975-76 at Site 1, RBOSP.

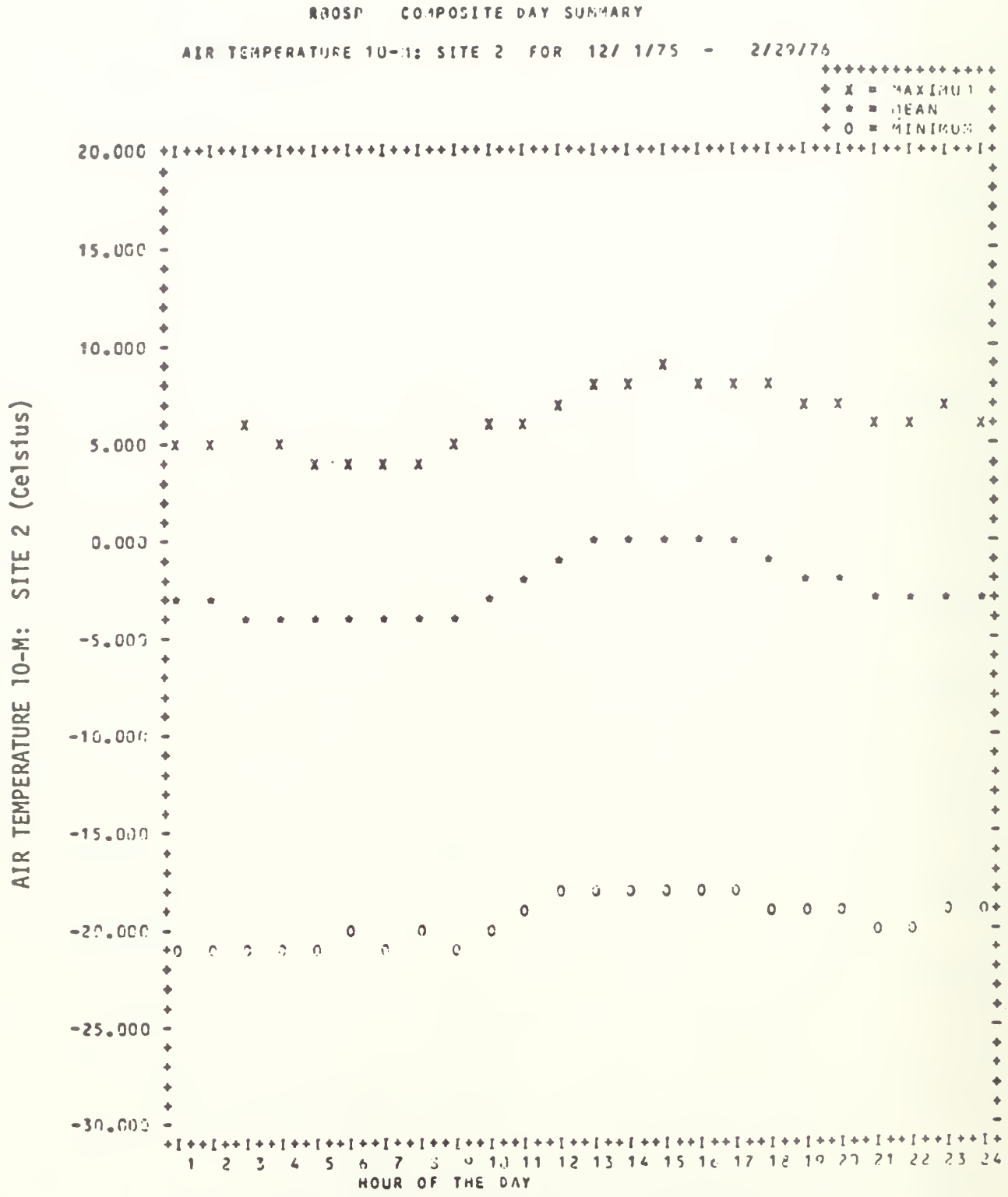


Figure 2.2-14. Air temperature, 10-m level (minimum, maximum, and mean by hour of the day) for Winter 1975-76 at Site 2, RBOSP.

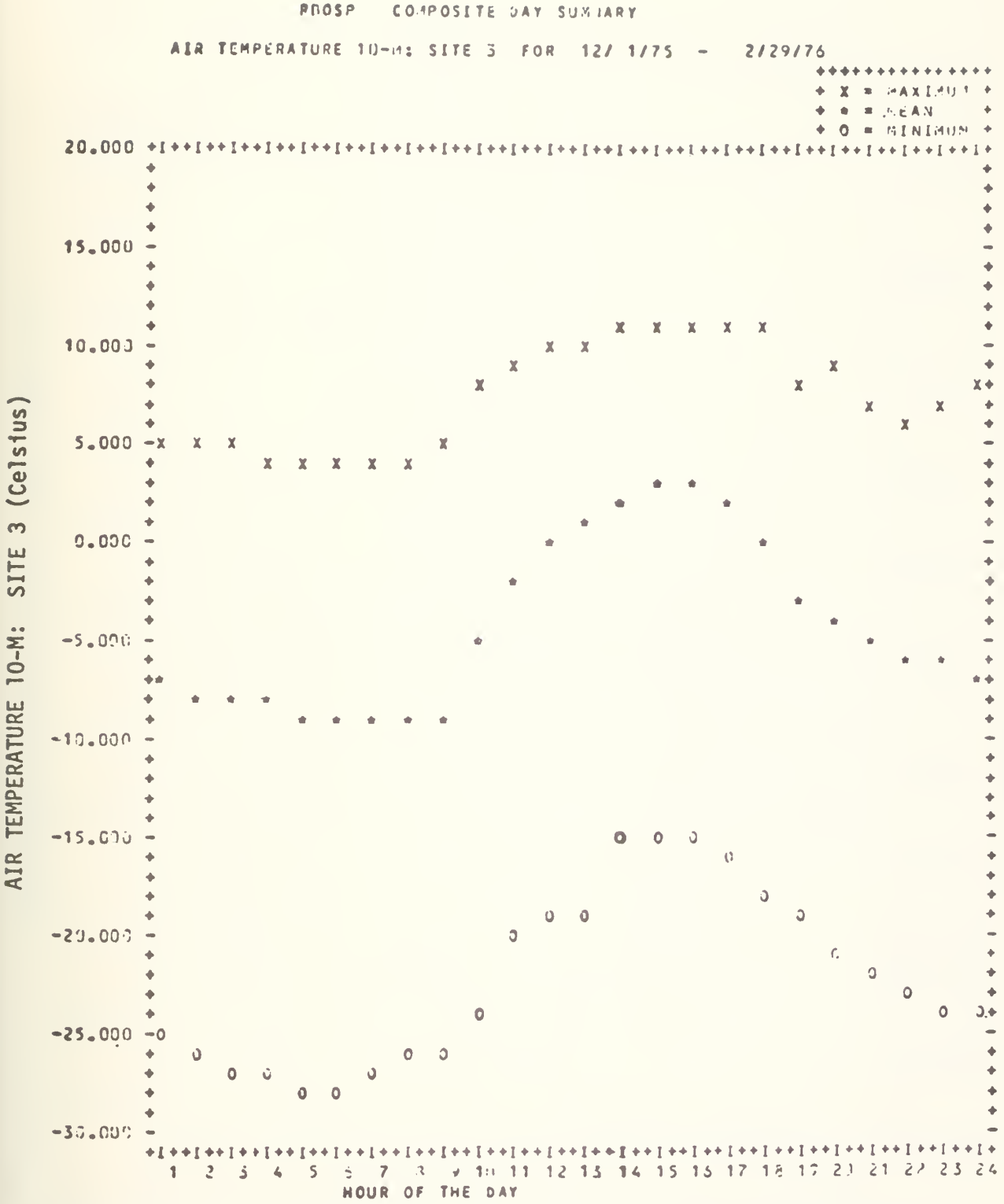


Figure 2.2-15. Air temperature, 10-m level (minimum, maximum, and mean by hour of the day) for Winter 1975-76 at Site 3, RBOSP.

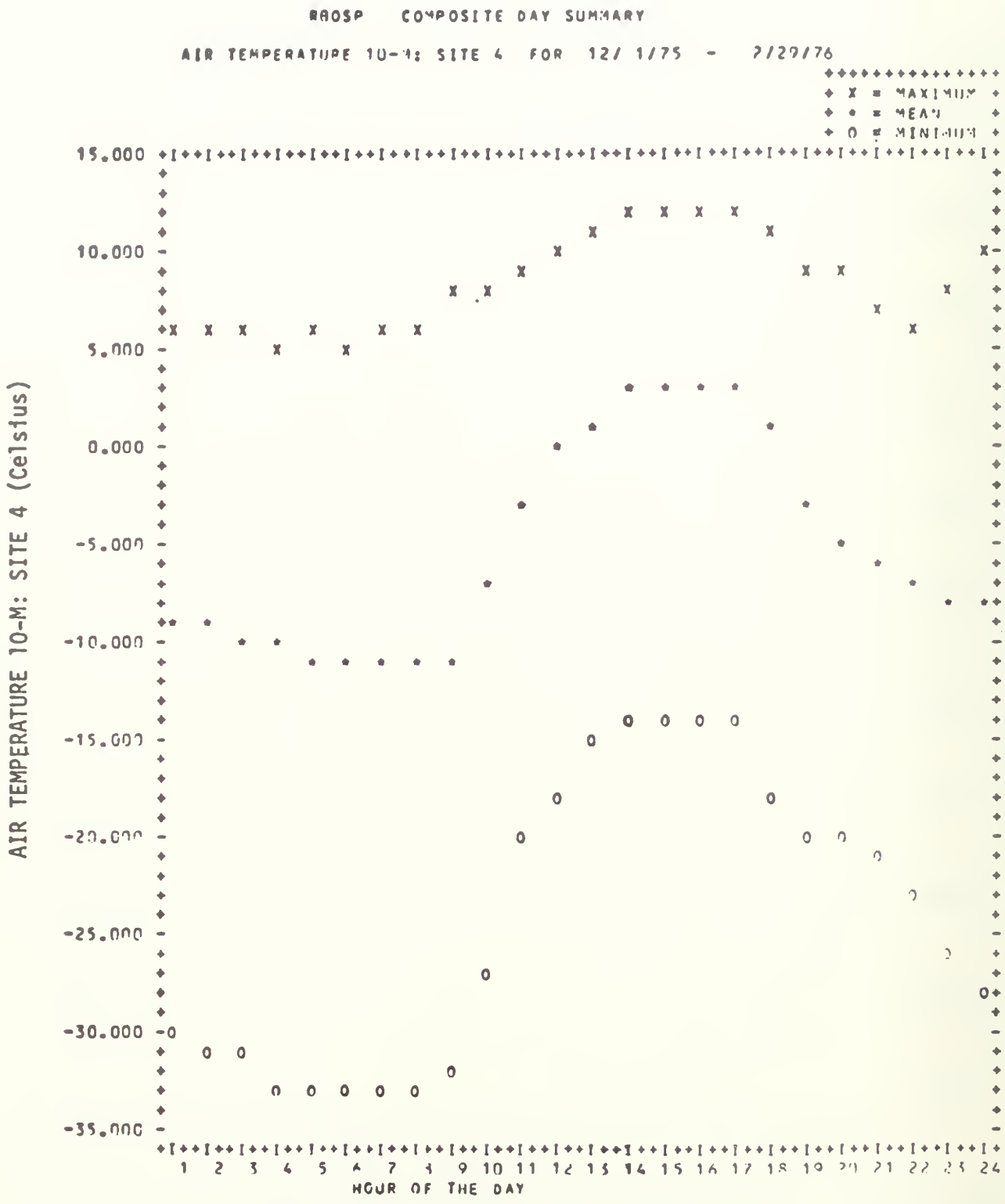


Figure 2.2-16. Air temperature, 10-m level (minimum, maximum, and mean by hour of the day) for Winter 1975-76 at Site 4, RBOSP.

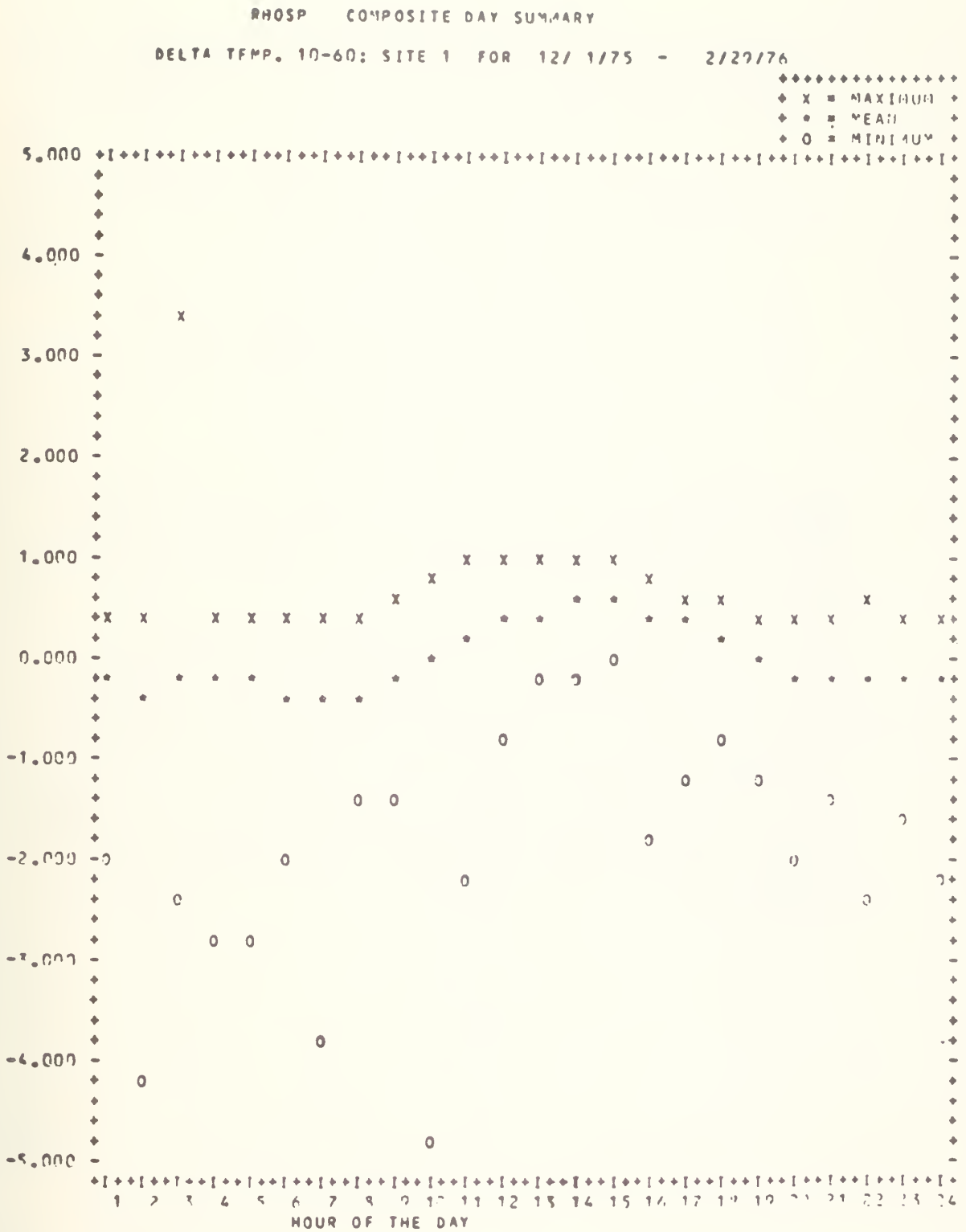


Figure 2.2-17. Temperature difference between 10-m and 60-m levels (minimum, maximum, and mean by hour of the day) for Winter 1975-76 at Site 1, RBOSP.

The percent of occurrence of the modified Pasquill stability categories for Winter 1975-76 and associated mean wind speeds are presented in Table 2.2-2. Stability categories were calculated according to the following criteria:

Stability Index	Temperature change (C) with heights per 100 m
A	$\Delta T < -1.9$
B	$-1.9 \leq \Delta T < -1.7$
C	$-1.7 \leq \Delta T < -1.5$
D	$-1.5 \leq \Delta T < -0.5$
E	$-0.5 \leq \Delta T < 1.5$
F	$1.5 \leq \Delta T < 4.0$
G	$4.0 \leq \Delta T$

The wind speeds, as a function of stability category, show a definite relationship. Category A has the highest average wind speed and E has the lowest. The slightly stable Category E occurred most often during nighttime hours with F and G occurring in early morning.

Figure 2.2-18 graphically presents the minimum, maximum, and mean composite day relative humidities as a function of hour of day for Winter 1975-76. The relative humidity data were taken at the 10-m level at Site 1. There was a significant decrease (14%) in the average relative humidity at sunrise. The effect is probably due to the surface heating of the air. This composite daily transition period occurs over 5 hours. The decrease may also arise from the increased thermally generated turbulent mixing caused by the reversal of the average lapse rate from slightly stable to slightly unstable and the increased surface temperature.

Table 2.2-2. Percent of occurrence of the Pasquill stability classes at Site 1. Stability category determined from the temperature difference between the 10- and 60-m levels during the Winter 1975-76, RBOSP.

Stability Classification	Pasquill Categories	Temperature Change with Height (C/100 m)	Percent of Occurrence	Mean Wind Speed (mph)
Extremely Unstable	A	Less than -1.9	0.19	12.76
Moderately Unstable	B	-1.9 to -1.7	0.84	8.96
Slightly Unstable	C	-1.7 to -1.5	1.35	7.87
Neutral	D	-1.5 to -0.5	36.79	9.50
Slightly Stable	E	-0.5 to 1.5	51.09	5.58
Moderately Unstable	F	1.5 to 4.0	9.10	4.33
Extremely Stable	G	Greater than 4.0	0.65	2.82

SOURCE: David H. Slade, Editor, Meteorology and Atomic Energy Nat. Tech. Serv. TID-24190, pp. 102-103, 1971.

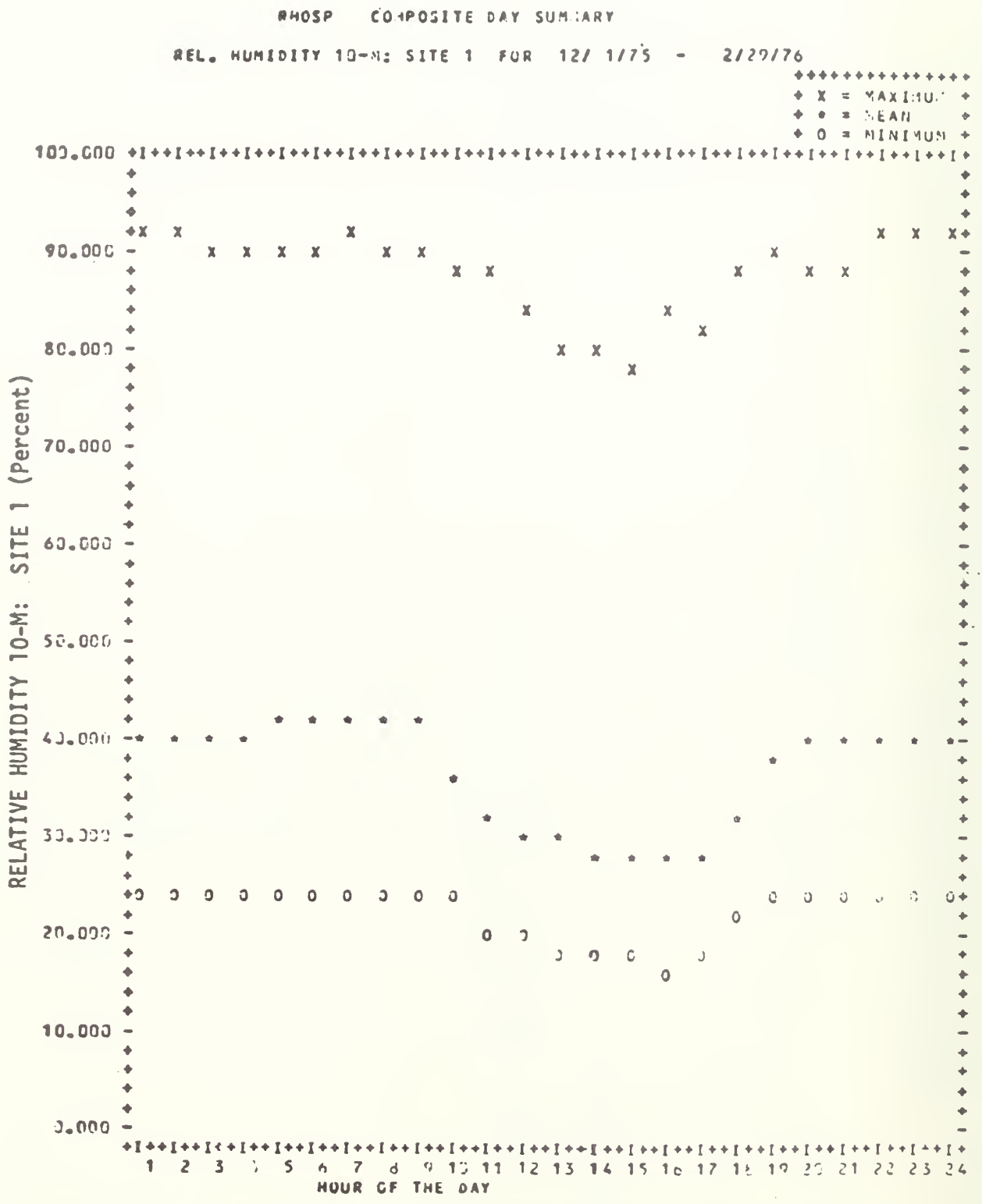


Figure 2.2-18 Relative humidity, 10-m level (minimum, maximum, and mean by hour of the day) for Winter 1975-76 at Site 1, RBOSP.

2.2.2 Upper Air Studies

2.2.2.1 Objectives

No change has occurred since Progress Report 5-Summary. See Section 2.2.2.1 in Progress Report 4-Summary for specific objectives for the upper air studies.

2.2.2.2 Methods

No change has occurred since Progress Report 5-Summary. See Section 2.2.2.2. in Progress Report 2-Summary for specific methods used in the temperature profile measurements.

2.2.2.3 Results

An upper air study was not performed during this quarter. The remaining upper air study planned is scheduled in the future.

2.2.3 Miscellaneous

The meteorological parameters grouped into this category are precipitation, evaporation, solar radiation, noise, visibility, snow course, and tracer studies. All these parameters, except precipitation, tracer studies and evaporation, are measured only at Site 1. Evaporation measurement is made at Site 3 because of water availability. The evaporation rate and visibility are not monitored continuously, but are recorded on a routine basis.

2.2.3.1 Precipitation Measurements

2.2.3.1.1 Objectives

No change has occurred since Progress Report 5-Summary. See Section 2.2.3.1.1 in Progress Report 2-Summary for specific methods used in the precipitation measurements.

2.2.3.1.2 Methods

No change has occurred since Progress Report 5-Summary. See Section 2.2.3.1.2 in Progress Report 2-Summary for specific methods used in the precipitation measurements.

2.2.3.1.3 Results

The precipitation data summary for Winter 1975-76 is presented in Table 2.2-3. The total and daily amounts of precipitation are shown for each site. Maximum total precipitation for 1 day was 0.19 inch at Site 1 on 20 February 1976.

Site 3 registered the largest total precipitation (0.93 inches for the Winter 1975-76 season.

Table 2.2-3. Precipitation data for Winter 1975-76, RBOSP.
(Values are presented in inches of water.)

Date	Site 1 Total	Site 2 Total	Site 3 Total	Site 4 Total
12/13/75	--	--	0.04	0.09
12/14/75	--	--	0.11	0.01
12/25/75	--	--	0.01	0.04
12/30/75	--	0.01	0.07	0.01
12/31/75	0.01	--	0.18	0.06
December Total	0.01	0.01	0.41	0.21
1/1/76	--	--	0.01	--
1/3/76	--	--	0.01	--
1/5/76	--	--	0.01	--
1/6/76	--	--	--	0.02
1/24/76	--	--	0.01	0.02
1/25/76	0.01	--	0.02	0.02
January Total	0.01	--	0.06	0.06
2/5/76	0.01	--	--	--
2/6/76	0.08	0.01	0.09	0.07
2/9/76	--	--	0.01	--
2/10/76	0.02	--	0.04	0.04
2/14/76	0.07	--	0.02	0.01
2/15/76	0.03	--	0.04	0.03
2/16/76	0.02	--	0.01	--
2/17/76	0.01	--	0.01	0.04
2/19/76	0.14	0.01	0.07	0.12
2/20/76	0.19	--	0.17	0.09
February Total	0.57	0.02	0.46	0.40
Winter Total	0.59	0.03	0.93	0.67

Upon reviewing the precipitation data, the cumulative values appear to be lower than other data in the general area. Additional calibration efforts were performed to substantiate the quantity of precipitation entering the precipitation gauges. This calibration data substantiates the fact that the instruments are measuring quantities of precipitation entering the gauge within manufacturers' specifications.

Additional efforts to enhance the measuring technique are in process with RBOSP.

2.2.3.2 Evaporation Measurements

2.2.3.2.1 Objectives

No change has occurred since Progress Report 5-Summary. See Section 2.2.3.2.1 in Progress Report 2-Summary for specific objectives of the evaporation measurements.

2.2.3.2.2 Methods

No change has occurred since Progress Report 5-Summary. See Section 2.2.3.2.2 in Progress Report 2-Summary for specific methods used in the evaporation measurements.

2.2.3.2.3 Results

Evaporation rate measurements were discontinued until warmer weather prior to Winter 1975-76 season.

2.2.3.3 Solar Radiation Measurement

2.2.3.3.1 Objectives

No change has occurred since Progress Report 5-Summary. See Section 2.2.3.3.1 in Progress Report 2-Summary for specific objectives of the solar radiation measurements.

2.2.3.3.2 Methods

No change has occurred since Progress Report 5-Summary. See Section 2.2.3.3.2 in Progress Report 2-Summary for specific methods used in the solar radiation measurements.

2.2.3.3.3 Results

The minimum, maximum, and mean composite day solar radiation measurements as a function of hour of the day for Winter 1975-76 are graphically presented in Figure 2.2-19. Solar radiation data were taken at 1.2 m above ground level at Site 1. The seasonal and hourly minimum, maximum, and mean values of the solar radiation are presented in Table 2.2-4.

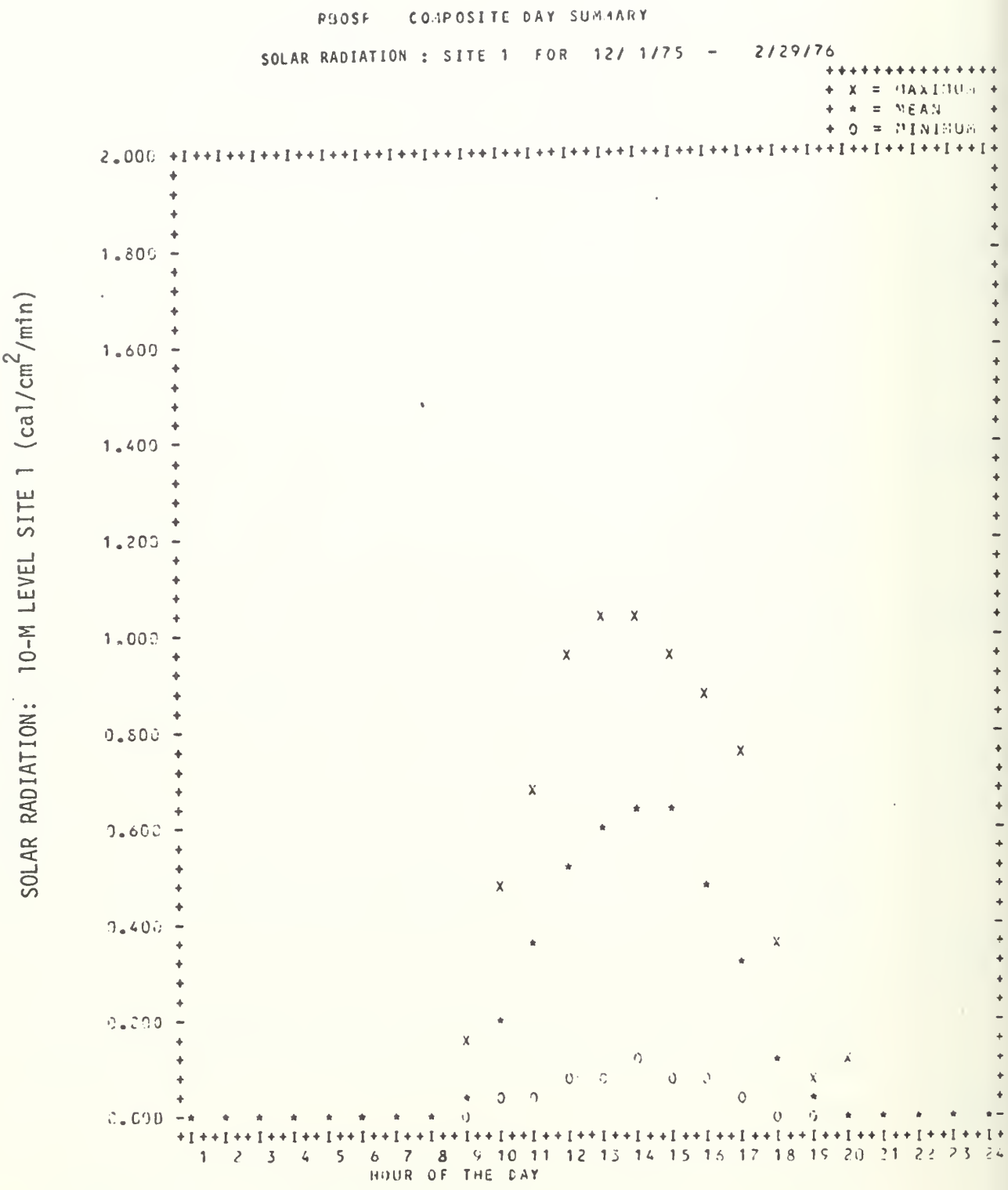


Figure 2.2-19. Solar radiation (minimum, maximum, and mean by hour of the day) for Winter 1975-76 at Site 1, RBOSP.

Table 2.2-4. Solar radiation, seasonal and monthly summary for Winter 1975-76, values are in Langleys or cal/cm^2/min, RBOSP.

	December	January	February	Winter 1975
Minimum	0.00	0.00	0.00	0.00
Maximum	0.87	0.84	1.03	1.03
Mean	0.14	0.16	0.21	0.17

2.2.3.4 Noise Measurements

2.2.3.4.1 Objectives

Baseline ambient noise levels are measured to establish a pre-development reference to which noise levels during future operations can be compared.

2.2.3.4.2 Methods

Measurements were made during 11 non-consecutive 24-hr periods at each of the four sites. The data are measured with a Digital Acoustics, Inc. Model DA-100 with Model DA-104 octave filter set and recorded in analog format on an Esterline Angus A601-C recorder. Measurements are taken in several octave bands to permit analysis of noise sources.

2.2.3.4.3 Results

Noise data from the four sites covering the period August through December 1975 were analyzed to determine maximum, minimum and mean values for each of the collection days. The results are summarized in Table 2.2-5.

2.2.3.5 Visibility Measurements (on Tract)
(a)

2.2.3.5.1 Objectives
(a)

No change has occurred since Progress Report 5. See Section 2.2.3.5.1 in Progress Report 2 for specific objectives of the visibility measurements.

2.2.3.5.2 Methods
(a)

No change has occurred since Progress Report 5. See Section 2.2.3.5.2 in Progress Report 2 for specific methods used in the noise measurements.

Table 2.2-5 Noise Levels measured at Sites 1, 2, 3, and 4, RBUSP.

Day No.	Octave Band Center Frequency (Hz)	NOISE LEVEL (dB)***											
		SITE 1			SITE 2			SITE 3			SITE 4		
		Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean
1	A**	55	50	52	52	43	46	52	44	50	53	50	51
2	31.5	58	52	55	70	56	58	59	53	56	60	53	57
3	63	62	57	59	62	55	56	58	55	56	60	57	58
4	125	57	53	56	60	49	52	63	54	56	55	54	55
5	250	58	49	54	52	45	48	56	50	51	45	45	45
6	500	44	40	42	38	35	37	45	34	40	53	48	50
7	1000	53	47	50	45	34	40	46	36	42	52	45	47
8	2000	55	49	51	55	45	48	53	46	51	52	46	51
9	4000	*	*	*	55	47	52	54	47	49	77	67	74
10	8000	*	*	*	52	43	50	51	44	48	78	70	72
11	16000	30	27	32	*	*	*	48	28	35	38	28	34

* Data not available
** A weighting - units in dBA
*** Ref. level $20N/m^2$

2.2.3.5.3 Results
(a)

During Winter 1975-76, visibility ranged from 5 to 150 miles for each period that data were recorded. The 5 mile visibility occurred on 19 February 1976 (Tables 2.2-6 through 2.2-8).

2.2.3.5 Visibility Measurement (Piceance Creek Basin Area)
(b)

2.2.3.5.1 Objectives
(b)

The objectives of the visibility program for the Piceance Creek basin area were described in Section 2.2.5.3.1(b) of Progress Report 5 - Summary.

2.2.3.5.2 Methods
(b)

The methods for this program were described in Section 2.2.5.3.2 (b) of Progress Report 5 - Summary. Methods for the basin-wide visibility studies vary from those used in the Tract C-a visibility studies. These methods were presented in Progress Report 2.

2.2.3.5.3 Results
(b)

During the Winter 1975-76 monitoring period (December 1975, January and February 1976), visual range measurements were made during 15 scheduled days of photography over a three month period. Of a possible 420 visual range measurements 367 were obtained for an 87% recovery. At least some measurements were made on each day of the study and measurements were obtained for each view. Measurements of visual range during the Winter period were occasionally hampered by snowstorms which restricted visibility and made photography impossible.

Daily mean visual ranges fluctuated considerably during the Winter quarter; variations of 50 to 60 miles during a one-week period were common. The daily mean visual range obtained every 54th day during the quarter is listed in Table 2.2-9.

Table 2.2-6 Visibility data for December 1975, RBOSP.

Date of Observation	Time of Observation Hours (MST)	Precipitation in Prior 24 hours (Inches)	Sector Visibility N	E	S	W	Prevailing Visibility (Miles)	Comments
12/3/75	1200	0	150	150	150	150	150	Estimated cloud coverage <5%.
12/6/75	0800	0	150	150	150	150	150	Estimated cloud coverage 40%.
12/9/75	1230	0	150	150	150	150	150	No clouds visible. Light winds.
12/12/75	0715	0	100	125	100	100	100	Estimated cloud coverage 100%. Very light snowfall.
12/15/75	1600	0	150	150	150	150	150	Estimated cloud coverage <5%.
12/18/75	1200	0	150	150	150	150	150	No clouds visible.
12/21/75	1440	0	150	150	150	150	150	Estimated cloud coverage 45%.
12/24/75	1308	0	150	150	150	150	150	Estimated cloud coverage 45%.
12/27/75	1345	0	80	80	80	80	80	Estimated cloud coverage 80%. Windy and overcast.
12/30/75	1200	0	150	150	150	150	150	Estimated cloud coverage 3%.

Table 2.2-7. Visibility data for January 1976, RBOSP.

Date of Observation	Time of Observation Hours (MST)	Precipitation in Prior 24 hours (Inches)	Sector Visibility N	E	S	W	Prevailing Visibility (Miles)	Comments
1/2/76	1930	0	>100	>100	>100	>100	>100	Estimated cloud coverage 60%.
1/5/76	1300	0	60	60	60	60	60	Estimated cloud coverage 99%.
1/8/76	1430	0	60	60	60	60	60	Estimated cloud coverage 60%.
1/11/76	1340	0	150	150	150	150	150	Estimated cloud coverage 5%.
1/14/76	1100	0	150	150	150	150	150	Estimated cloud coverage 10%.
1/17/76	1300	0	150	150	150	150	150	No clouds visible.
1/20/76	1400	0	150	150	150	150	150	No clouds visible.
1/23/76	1320	0	150	150	150	150	150	Estimated cloud coverage 40%.
1/26/76	1250	0.01	85	85	85	85	85	Estimated cloud coverage 75%.
1/29/76	1215	0	150	150	150	150	150	No clouds visible.

Table 2.2-8. Visibility data for February 1976, RBOSP.

Date of Observation	Time of Observation Hours (MST)	Precipitation in Prior 24 hours (Inches)	Sector Visibility N	E	S	W	Prevailing Visibility (Miles)	Comments
2/1/76	1600	0	150	150	150	150	150	Estimated cloud coverage 60%.
2/4/76	1212	0	60	60	60	60	60	Estimated cloud coverage 100%. Occasional light snow flurries.
2/7/76	1200	0	80	80	80	80	80	Estimated cloud coverage 60%.
2/10/76	1150	0.01	12	12	12	12	12	Estimated cloud coverage 100%. Frequent snow showers.
2/13/76	1015	0	150	150	150	150	150	No clouds visible.
2/16/76	1155	0.05	150	150	150	150	150	Estimated cloud coverage 25%.
2/19/76	1630	0	5	100	100	5	10	Estimated cloud coverage 90%.
2/22/76	1400	0	150	150	150	150	150	Estimated cloud coverage 10%.
2/25/76	1230	0	150	150	150	150	150	Estimated cloud coverage 10%.
2/28/76	1400	0	150	150	150	150	150	Estimated cloud coverage 80%.

Table 2.2-9 Mean Visual Range (miles) for Each Day of Monitoring Piceance Creek Basin, Colorado, Winter, 1975-76

Date	Mean Visual Range
December 2, 1975	98
8	88
14	32
20	109
27	53
January 2, 1976	44
8	66
14	102
20	91
26	57
February 1, 1976	105
7	46
13	85
19	102
25	79

Monthly mean visual ranges obtained during the Winter months varied from 72 miles in January to 86 miles in December; maximum values were near 140 to 150 miles; minimum values were below 20 miles. The general visual range characteristics of each of the Winter months are listed in Table 2.2-10.

Table 2.2-10 Visual Range (miles) Statistics for all Views Combined for Each Month of Monitoring Piceance Creek Basin, Colorado Winter, 1975-76

Month	Mean	Maximum	Minimum	Standard Deviation
December	86	147	17	31.1
January	72	137	27	29.2
February	84	149	25	28.2

The monthly composite distribution of visual range shown in Figure 2.2-20 illustrates the higher frequency of low values during January and the large variation in values during December and February. The median visual ranges during the Winter period were 82, 64, and 84 miles for December, January, and February, respectively.

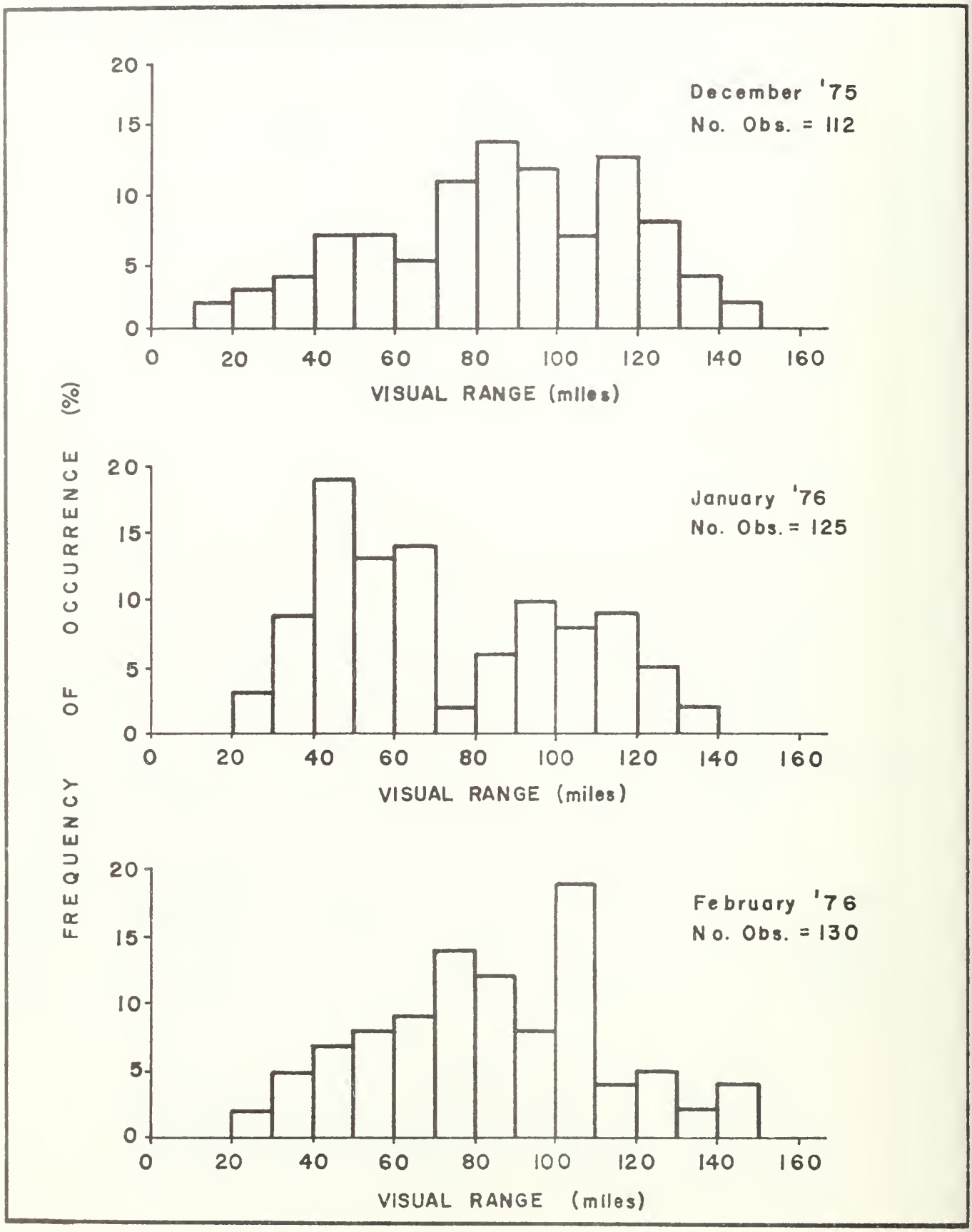


Figure 2.2-20 Monthly Composite Distribution of Visual Range, Piceance Creek Basin, Colorado, Winter 1975-76

During the Winter Quarter, visual ranges were generally high; ninety-five percent of the visual range measurements were greater than 33 miles; 50 percent were greater than 81 miles. Pertinent statistics for each view (see Figure 2.2-21 for locations of views) and all views combined during the Winter Quarter are listed in Table 2.2-11.

Table 2.2-11 Visual Range Summary (miles) Piceance Creek Basin, Colorado, Winter, 1975-76

View	Mean	Maximum	Minimum	5 Percentile	Standard Deviation
I	87	143	31	41	23.9
II	66	115	31	41	19.2
III	83	149	17	30	34.1
IV	86	147	22	26	35.4
Composite	80	149	17	33	30.0

The lower mean visual range exhibited in View II suggests a localized condition affecting visibility along the View II alignment. A possible explanation may be that View II lies within the bounds of the Piceance Creek basin and has a larger portion of its path affected by basin air. Definite conclusions are impossible; however, due to a small sample set and the lack of additional supporting information only preliminary suppositions can be made at this time.

For purposes of describing the general state of visibility independent of direction, a composite distribution of all visual range measurements during the Winter Quarter is illustrated in Figure 2.2-22. Visual ranges obtained during this period occurred more frequently between 100 and 110 miles, although the frequency of occurrence varied little from 40 to 110 miles, suggesting the variability of the season.

To adequately distinguish mean values for all views during a season from the mean visual range for an individual view, the term "generalized visibility" has been chosen to represent the composite mean visual range. Generalized visibility is used to describe areal visibility while reserving the term visual range for a single path length. The generalized visibility in the Piceance Creek basin area during the Winter Quarter was 80 miles. This value can be compared with the results of a similar study conducted over an eight month period (September 74 - April 75) at Grand Valley, Colorado. The generalized visibility during the study was 86 miles.

Figure 2.2-21 Basin-wide Visibility Study Sites

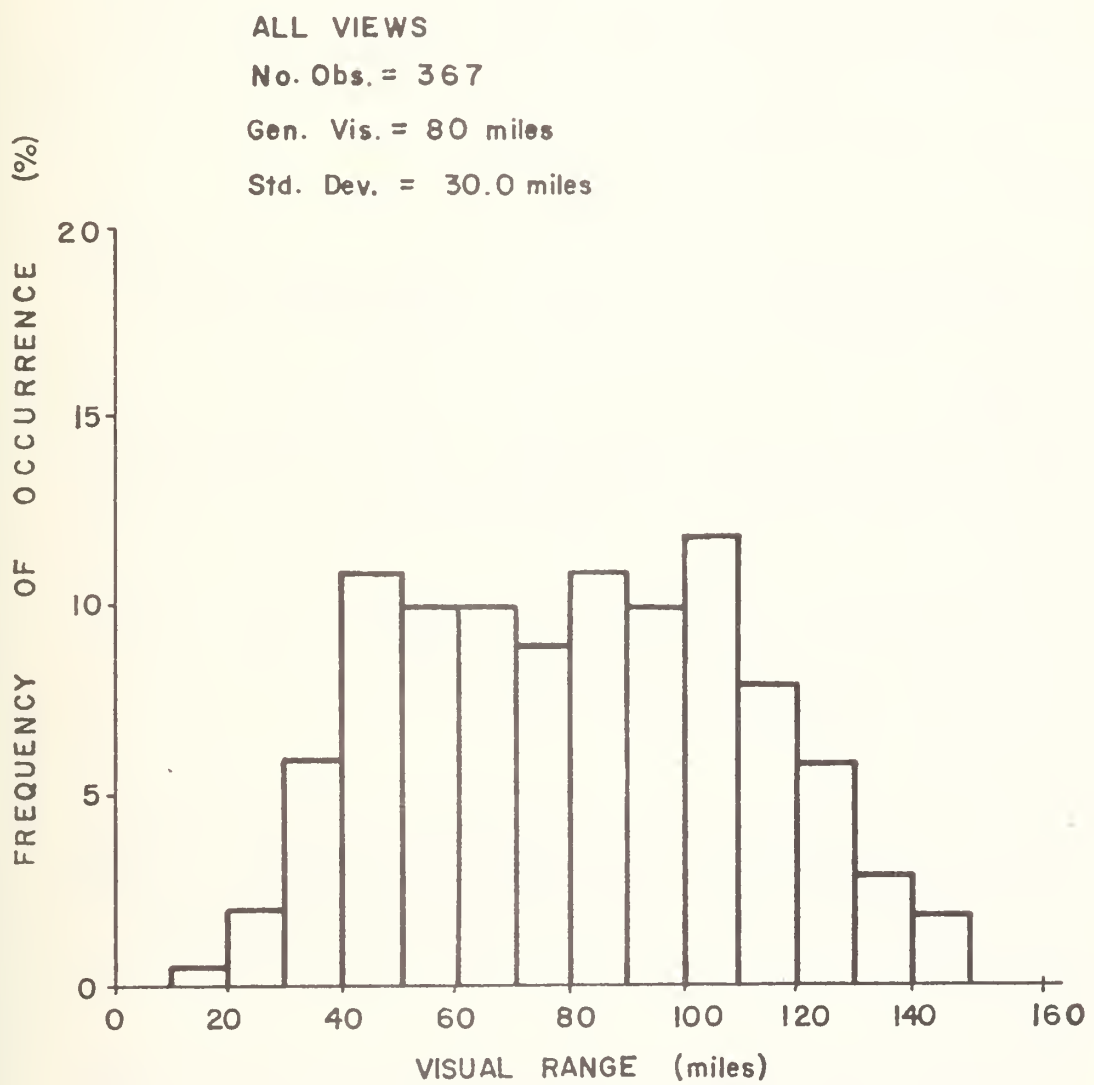


Figure 2.2-22 Composite Visual Range Distribution, Piceance Creek Basin, Colorado, Winter 1975-76

Mean hourly visual ranges for each view and for all views combined are presented in Figure 2.2-23 for each hour of photography. Separation of Views I and II from Views III and IV in Figure 2.2-23 merely facilitates comparison of individual trends. Hourly fluctuations in the mean visual range of Views I and II exhibit little similarity, with the exception of the late afternoon decrease in the visual range common to all views. The mean hourly visual ranges in Views III and IV exhibit similar changes throughout an average day. The visual range in both views decreases during early morning hours, increases slightly until early afternoon, then decreases to the minimum mean visual range for the day. The composite trend exhibits only slight variations during the day.

2.2.3.6 Tracer Study Measurements

2.2.3.6.1 Objectives

No change has occurred since Progress Report 5-Summary. See Section 2.2.3.6.1 in Progress Report 2-Summary for specific objectives of the Tracer Study measurements.

2.2.3.6.2 Methods

No change has occurred since Progress Report 5-Summary. See Section 2.2.3.6.2 in Progress Report 2-Summary for specific methods used in the Tracer Study Measurements.

2.2.3.6.3 Results

Tracer study measurements are being scheduled.

2.2.3.7 Snow Course Measurements

2.2.3.7.1 Objectives

This special study routine is designed to provide additional information to the basic precipitation measurements. With this information, precipitation in the form of snow at Site 1 can be segregated from the automatic precipitation measurements.

2.2.3.7.2 Methods

No change has occurred since Progress Report 5. See Section 2.2.1.2 in Progress Report 2 for specific methods used in snow course measurements.

2.2.3.7.3 Results

The maximum snowfall measured for Winter 1975-76 was 7.0 in, see Table 2.2-12.

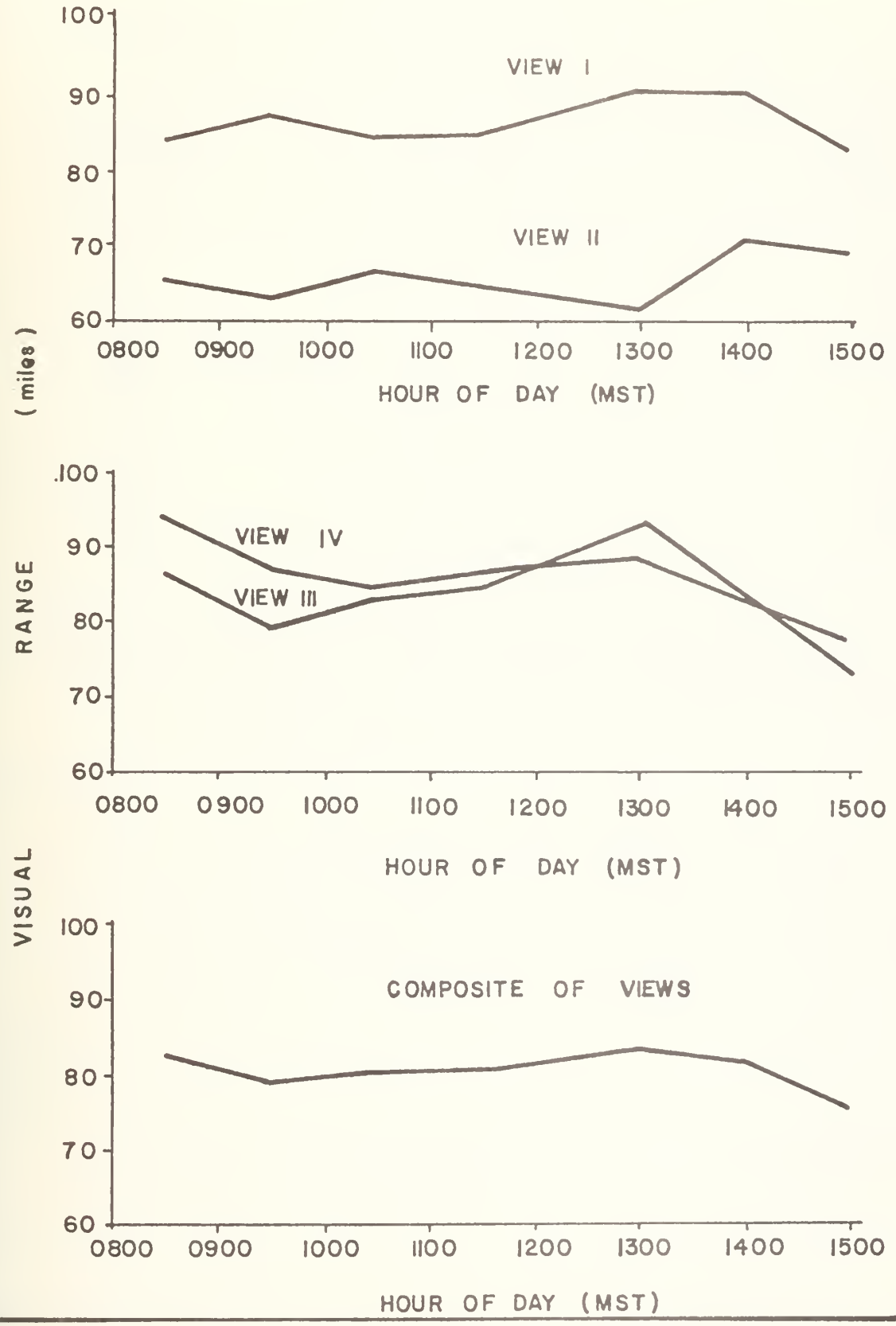


Figure 2.2-23 Variation in the Mean Hourly Visual Range, Piceance Creek Basin, Colorado, Winter 1975-76

Table 2.2-12 Snow Course Measurements for Winter 1975-76, RBOSP

Date of Sample	Total Snow Depth (in.)	Water Equilibrium (In. of H_2O)
12/15/75	4.0	.02
12/24/75	2.0	.01
12/31/75	6.0	.10
1/8/76	4.3	.11
1/16/76	4.3	.10
1/26/76	4.5	.10
2/1/76	3.8	.10
2/7/76	5.8	.12
2/15/76	2.0	.10
2/16/76	2.5	.10
2/22/76	7.0	.12
2/28/76	NA*	NA*

*NA = No measurement taken due to much wind and warm temperatures: most of the course base boards were exposed. No snow has fallen since 2/22 measurement.

2.3 Terrestrial Studies

The terrestrial program is designed to gather two years of baseline data on vegetation, small mammals, large mammals, mammalian predators, avifauna, herpetofauna, invertebrates, domestic livestock, and threatened and endangered species. A variety of standardized methodologies is employed to gather these data in the field. All studies are designed to gather the definitive data necessary to describe existing ecosystems as required by the environmental stipulations in the oil shale lease.

2.3.1 Vegetation

Vegetation data were not collected for the reporting quarter December 1975 through February 1976.

2.3.2 Grazing Exclosure

2.3.2.1 Objectives

No changes have been made since Progress Report 4-Summary. See Section 2.3.2.1 in Progress Report-4 Summary for the objectives of the grazing exclosure study.

2.3.2.2 Methods

No changes have been made since Progress Report 4-Summary. See Section 2.3.2.2 in Progress Report-4 Summary for specific methods used in the grazing exclosure study.

2.3.2.3 Results

The shrub photoplot counts have been completed and filed as baseline data for comparison with results from future sampling periods. These data have no immediate or independent application prior to acquisition of future comparative data. When such data are collected, the change in the number of squares obscured will serve as an index of net growth (when change is positive) or utilization (when change is negative).

2.3.3 Small Mammals

2.3.3.1 Objectives

No changes have been implemented since Progress Report 2-Summary. See Section 2.3.3.1 of Progress Report 2-Summary for specific objectives of the small mammal program.

2.3.3.2 Methods

No changes have been implemented since Progress Report 3-Summary. See Section 2.3.3.2 in Progress Report 3-Summary for specific methods used in small mammal sampling.

2.3.3.3 Results

Small mammal live trapping operations were conducted during December 12-17, 1975. Due to adverse weather and road conditions, trapping was terminated on grids 5 (Mixed Brush), F (Douglas-fir), and G (Aspen) after two trap nights. All other grids were sampled for the entire five trap nights. Eighty-eight individuals comprising seven species were captured during the winter trapping operations.

The deer mouse (Peromyscus maniculatus) was the most abundant small mammal captured during December and accounted for 78.5% of the total relative abundance. It was represented in samples from all grids except grid 5 (Mixed Brush) and was most abundant on grid 7 (Upland Meadow) and grid E (Mixed Brush).

The red-backed vole (Clethrionomys gapperi) was the second most frequently trapped small mammal during December and it accounted for 12.6% of the total capture success. As in previous trapping periods, this species was encountered only on grids established in Douglas-fir and aspen vegetation and was most abundant in aspen.

The long-tailed vole (Microtus longicaudus) and the sagebrush vole (Lagurus curtatus) were the only other small mammal species on more than one grid during December. These species accounted for 3.4% and 2.3% of the total relative abundance, respectively.

The Colorado chipmunk (Eutamias quadrivittatus), bushy-tailed woodrat (Neotoma cinerea) and montane vole (Microtus montanus) were all represented by only one individual. Together, these three species accounted for only 3.2% of the total relative abundance for December.

Average adult weights for the deer mouse and the red-backed vole decreased slightly from the previous sampling period (September-October 1975). This weight decrease might be due to the recruitment of juveniles into the population after September and/or a reduced food supply. The paucity of weight data for the other species encountered during December precludes the formulation of conclusions concerning seasonal weight changes at this time.

Shannon-Weiner species diversity indices were low for all grids. Half the grids exhibited a value of 0.000, which indicates one or no species were captured. Three species were represented in samples from both grid A (Greasewood-sagebrush) and grid G (Aspen), but because of a more equitable distribution of individuals among species, and perhaps a greater trapping effort, the former grid showed the highest

species diversity for December. All other grid samples with non-zero diversity indices contained only two species.

Pitfall trapping was conducted during live trapping operations in December. However, pitfall traps were not operated at Site 1 (Bottomland Meadow), Site 7 (Upland Meadow), Site 8 (Riparian), Site E (Mixed Brush), Site F (Douglas-fir) and Site G (Aspen) due to adverse weather and road conditions. Two shrews were captured in pitfalls established at Site 3 (Rabbitbrush). The species identification of these shrews has been confirmed as Sorex cinereus. Pitfalls operated at the other sites yielded no captures during December.

Removal trap lines were established in all the major vegetation types except aspen and mixed brush during December. However, trap success was low: only two deer mice (one from sagebrush and one from greasewood-sagebrush) were taken. Stomachs of all specimens examined contained only seeds.

Night spotlight surveys for medium-sized mammals, particularly lagomorphs, were conducted on the nights of February 26 and 28. However, the census route had to be truncated due to the adverse road conditions along Cathedral Bluffs. Although a number of deer were seen during this survey, the only lagomorphs observed were the cottontail (Sylvilagus sp.) and one white-tailed jackrabbit (Lepus townsendii).

2.3.4 Large Mammals

2.3.4.1 Objectives

No changes have been implemented since Progress Report 2-Summary. See Section 2.3.4.1 in Progress Report 2-Summary for the objectives of the large mammal program.

2.3.4.2 Methods

No changes have been implemented since Progress Report 3-Summary. See Section 2.3.4.2 in Progress Report 3-Summary for specific methods used in the large mammal program.

2.3.4.3 Results

Large mammal aerial surveys were conducted on December 4 and 18, 1975; January 5 and 29, 1976; and February 23, 1976. A census flight scheduled for February 9 was postponed and reattempted on February 14. That flight had to be cancelled partway through due to hazardous flying conditions and was repeated on February 23, 1976.

The number of mule deer, elk, and feral horses observed during each survey is presented in Table 2.3-1. Mule deer observed during the December surveys were generally in herds scattered throughout the study area. During early January, the deer were concentrated in

Table 2.3-1. Number of mule deer, elk, and feral horses observed during five aerial surveys conducted for RBOSP.

Date	Mule Deer	Elk	Feral Horses
December 4, 1975	88	0	69
December 18, 1975	367	0	59
January 5, 1976	174	0	65
January 29, 1976	184	0	47
February 23, 1976	287	11	44

herds located mostly to the east and southwest of Tract C-a. By February, however, the pattern of mule deer observations indicated that the majority of the deer were in herds to the east of Tract C-a. Elk were observed during only one survey and were located northwest of Tract C-a. Feral horses were observed on 84 Mesa during all surveys, but the majority of the horses observed were located on areas west and south of Tract C-a.

2.3.5 Mammalian Predators

2.3.5.1 Objectives

No changes have been implemented since Progress Report 2-Summary. See Section 2.3.5.1 in Progress Report 2-Summary for the objectives of the mammalian predator program.

2.3.5.2 Methods

No changes have been implemented since Progress Report 2-Summary. See Section 2.3.5.2 in Progress Report 2-Summary for specific methods used in the mammalian predator program.

2.3.5.3 Results

Predator scent stations were operated February 25-29, 1976. Snow drifts along Cathedral Bluffs Road prevented access to scent stations 1-8 on route A and 44-50 on route B. The number of operable scent stations was further reduced by melting snow and occasional gusty winds, which combined to obliterate tracks and upset scent capsule supports.

Coyote visits to scent stations on both survey routes were 2.5 times as numerous as weasel visits. The highest number of coyote visits recorded on any one day was three (days 1 and 5), while two was the highest number of weasel visits recorded on any one day.

Siren censuses were conducted on February 26 and 29, 1976. Stations 6 and 7 along Cathedral Bluffs Road were inaccessible both nights, and wind gusts over 10 mph eliminated one additional station on February 26 and two stations on February 28.

Havahart live traps were set and checked during the December 1975 small mammal sampling period, but no mammalian predators were captured.

2.3.6 Winter Track Counts

2.3.6.1 Objectives

No changes have been implemented since Progress Report 2-Summary. See Section 2.3.6.1 in Progress Report 2-Summary for objectives of the winter track count program.

2.3.6.2 Methods

No changes have been implemented since Progress Report 2-Summary. See Section 2.3.6.2 in Progress Report 2-Summary for specific methods used in the winter track count program.

2.3.6.3 Results

Winter track count transects were established at eight of the fourteen small mammal grid locations. Grids 7, E, F, and G (Upland Meadow, Mixed Brush, Douglas-fir, and Aspen, respectively) were inaccessible due to heavy snow accumulation on Cathedral Bluffs, and snow cover on grids 3 and B (Rabbitbrush and Pinyon-Juniper/South Slope, respectively) was insufficient to establish track count transects; consequently, these six grids were not sampled. In addition, warm weather and clear skies caused rapid snowmelt and excessive bare ground at the three lowest elevation locations (Bottomland Meadow, Greasewood-Sagebrush and Sagebrush/flat), resulting in the collection of only one day's data for these three transects. Two collecting periods totalling approximately 48 hours were completed during February 25-27, 1976 for each of the five remaining transects.

The tracks of at least six animal species were encountered on the eight transects surveyed. Mule deer tracks were the most common of any tracks recorded. The greatest number of species was encountered on transects traversing the pinyon-juniper vegetation type.

In north slope/pinyon-juniper and pinyon-juniper/sagebrush, the tracks of at least four species were recorded. In pinyon-juniper/mixed brush, the tracks of at least three species were recorded. Cottontail, chipmunk and mouse/vole tracks were recorded on all three pinyon-juniper transects. Chipmunks are normally torpid during the cold winter months. However, when the transects were surveyed, daytime ambient temperatures were unseasonably high, which may explain the unusually high number of chipmunk track crossings observed.

2.3.7 Avifauna

2.3.7.1 Objectives

No changes have been implemented since Progress Report 2-Summary. See Section 2.3.7.1 in Progress Report 2-Summary for the objectives of the avifauna program.

2.3.7.2 Methods

No changes have been implemented since Progress Report 4-Summary. See Section 2.3.7.2 in Progress Report 2-Summary for the objectives of the avifauna program.

2.3.7.3 Results

Inclement weather forced postponement of the February 1976 quantitative and qualitative general avifauna sampling program until March 1976. These data will be reported in Progress Report 7-Summary. An aerial raptor survey was conducted on January 28, 1976 and night owl surveys were conducted on January 28 and 29, 1976.

One golden eagle and five common ravens were observed on the aerial census. Four of these six birds were observed along Cathedral Bluffs. Four species of owls were recorded on the night surveys (Table 2.3-2). The saw-whet owl and the great-horned owl were the most abundant owl species recorded. The long-eared owl was recorded for the first time in the study area.

Opportunistic bird sightings during the reporting quarter December 1975 through February 1976 included: the sage grouse, the goshawk, the golden eagle, the bald eagle, the red-tailed hawk, and the prairie falcon. During the winter quarter, the common raven was the most frequently observed raptorial bird.

2.3.8 Reptiles and Amphibians

Reptile and amphibian data were not collected during the reporting quarter.

2.3.9 Invertebrates

Invertebrate data were not collected during the reporting quarter.

2.3.10 Domestic Livestock

2.3.10.1 Objectives

No changes have been implemented since Progress Report 4-Summary. See Section 2.3.10.1 in Progress Report 4-Summary for the objectives of the domestic livestock program.

2.3.10.2 Methods

No changes have been implemented since Progress Report 4-Summary. See Section 2.3.10.2 in Progress Report 4-Summary for the specific methods used in the domestic livestock program.

2.3.10.3 Results

Domestic livestock data were collected concurrently with large mammal data during flights on December 4 and 18, 1975; January 5 and 29, 1976; and February 23, 1976. Table 2.3-3 shows the numbers of domestic livestock observed during these surveys. Most of the domestic livestock observed were scattered throughout the major gulches and creek bottoms east and north of Tract C-a during December.

Table 2.3-2. Owl species encountered on night transects during winter, 1976 for RBOSP.

Species	Total Number Observed Jan. 28	Jan. 29	Total	% Relative Abundance (both nights)1/
Great horned owl	5	1	6	27.3
Short-eared owl	0	1	1	4.6
Long-eared owl	1	2	3	13.6
Saw-whet owl	3	9	12	54.5

1/ Percent Relative Abundance = $\frac{\text{Total number of individual species A}}{\text{Total number of individuals all species}} \times 100$

Table 2.3-3. Number of domestic livestock observed during the winter quarter (1975-76) aerial surveys for RBOSP.

Date	Number Observed
December 4, 1975	301
December 18, 1975	385
January 5, 1976	263
January 29, 1976	306
February 23, 1976	137

However, during the remaining surveys, most animals were observed in Ryan and Black Sulphur gulches.

2.3.11 Remote Sensing

2.3.11.1 Objectives

No changes have been implemented since Progress Report 4-Summary. See Section 2.3.11.1 in Progress Report 4-Summary for objectives of the remote sensing program.

2.3.11.2 Methods

No changes have been implemented since Progress Report 4-Summary. See Section 2.3.11.2 in Progress Report 4-Summary for the specific methods used in the remote sensing program.

2.3.11.3 Results

Aerial photographs have been arranged in flight lines. Remote sensing analysis is under way.

2.3.12 Threatened and Endangered Species

No threatened or endangered species were recorded during the reporting quarter December 1975 through February 1976.

2.4 Aquatic Studies

The Aquatic Baseline Data Accumulation Program is intended to perform those environmental studies described in the Federal Register, Volume 39, Number 230, Part 3, Oil Shale Lease Environmental Stipulations and in the Tract C-a Exploratory Plan of May 1974. Specific lease requirements addressed were "The Lessee shall make studies of the flora and fauna . . . and also of the aquatic habitat as far downstream as the Mining Supervisor shall require." "The Lessee shall compile an inventory of natural surface features, such as springs and seeps."

No detailed studies of the aquatic ecosystems of Tract C-a have been made prior to the present baseline study. However, studies of similar habitats indicate that the composition and abundance of the aquatic flora and fauna are primarily determined by the permanency of flow.

The overall objective for the Aquatic Baseline Data Accumulation Program is to characterize the existing aquatic communities on and in the vicinity of Tract C-a. These studies will inventory aquatic habitats which may be affected by oil shale development. The ongoing programs are summarized in Table 2.4-1.

In order to fulfill these objectives, 35 sampling stations have been selected to represent the aquatic habitats present. Emphasis has been placed on Yellow Creek and the White River which are permanently flowing streams. The locations of aquatic sampling stations are depicted in Figure 2.4-1. Sampling periods discussed herein are October and November - December 1975. The condition (dry or flowing) of each station during this period and dates on which aquatic samples were taken during October and November - December are shown in Table 2.4-2. Physical, chemical, and biological measurements are taken concurrently at each sampling site.

2.4.1 Physical and Chemical Characteristics

2.4.1.1 Objectives

No change has occurred since Progress Report 3 - Summary. See Section 2.4.1.1 of Progress Report 3 - Summary for specific objectives.

2.4.1.2 Methods

No change in methods has occurred since Progress Report 3 - Summary. See Section 2.4.1.2 of Summary Progress Reports 2 and 3 for specific methods used in measuring the physical and chemical characteristics of the waters under study. See Table 2.4-3 for specific analytical methods.

Table 2.4-1. Summary of RBOSP Aquatic Sampling Programs October and November - December 1975.

Group Sampled	Objective	Methodology	No. of Sample Sites October	No. of Sample Sites Nov.- Dec.
Physical measurements	To measure existing parameters	Flow, O_2, pH, Cond., and temp. meters	29	30
Water chemistry	Analysis of certain chemical characteristics of particular biological significance	Pump-type or bottle-type	29	30
Phytoplankton	Population studies and species inventory	Pump-type or bottle type	29	30
Zooplankton	Population studies and species inventory	Wisconsin nets w/flow meter or pump	29	30
Periphyton	To estimate abundance, determine biomass and productivity	Scraped off rock	29	30
Benthos	Population studies and species inventory	Ekman, modified Surber, D-frame	29	30
Macrophytes	Species inventory	Random transect	29	30
Fish	Population studies, species inventory, condition, food habits	Electrofishing/ seining	15	15
Sediment chemistry	To measure existing chemical characteristics		29	30
Rare and endangered species			Opportunistic	
Springs & seeps			Opportunistic	
Water quality	To measure existing water quality in the White River near Yellow Creek		2	2

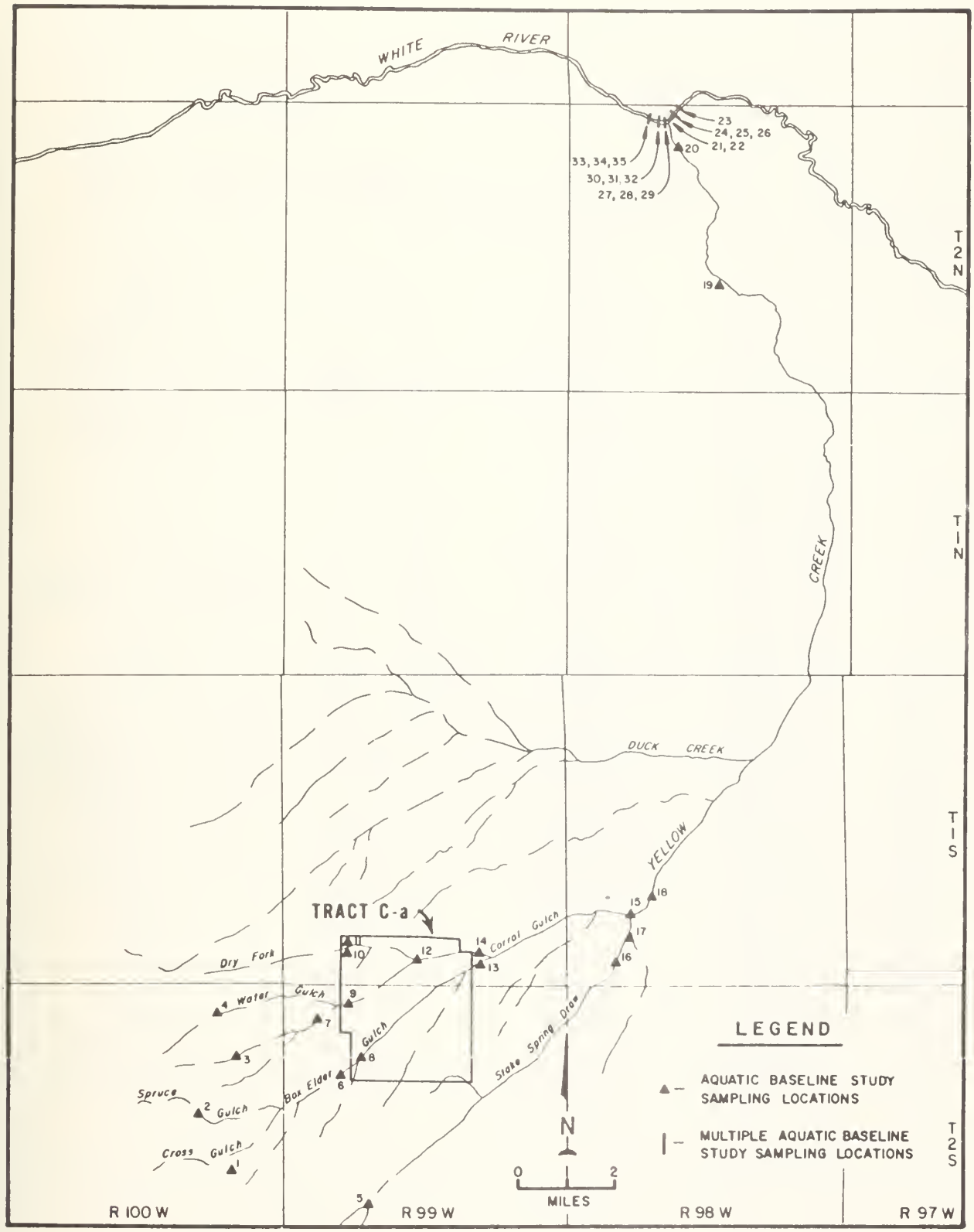


Figure 2.4-1. RBOSP Aquatic Sampling Locations

Table 2.4-2. Dates of sampling for RBOSP Aquatic Baseline Studies, October 1975 and November - December 1975.

Station	October		November - December	
	Date Sampled	Flow Condition	Date Sampled	Flow Condition
1	10- 2-75	Flowing	11- 6-75	Flowing
2	10- 2-75	Flowing	11-10-75	Flowing
3	10- 7-75	Flowing	11-21-75	Flowing
4	10- 7-75	Flowing	11-21-75	Flowing
5	10- 8-75	Flowing	12- 3-75	Flowing(Ice Covered)
6	10- 6-75	Dry	12- 3-75	Dry
7	10- 6-75	Flowing	12- 3-75	Flowing(Ice Covered)
8	10- 6-75	Flowing	12- 3-75	Flowing
9	10- 6-75	Flowing	12- 3-75	Flowing
10	10- 6-75	Dry	11-21-75	Dry
11	10- 6-75	Dry	11-21-75	Dry
12	10- 6-75	Flowing	12- 3-75	Frozen
13	10- 6-75	Flowing	12- 1-75	Flowing
14	10- 8-75	Flowing	12- 1-75	Flowing(Ice Covered)
15	10- 8-75	Dry	12- 1-75	Flowing(Ice Covered)
16	10- 8-75	Dry	12- 3-75	Dry
17	10- 8-75	Flowing	12- 1-75	Flowing
18	10- 8-75	Dry	12- 1-75	Flowing
19	10- 8-75	Flowing	11-25-75	Flowing(Ice Covered)
20	10-20-75	Flowing	11-24-75	Flowing(Ice Covered)
21	10-20-75	Flowing	11-24-75	Flowing(Ice Covered)
22	10-20-75	Flowing	11-24-75	Flowing(Ice Covered)
23	10-17-75	Flowing	11-24-75	Flowing(Slush)
24	10-14-75	Flowing	11-17-75	Flowing
25	10-14-75	Flowing	11-17-75	Flowing
26	10-14-75	Flowing	11-17-75	Flowing
27	10-16-75	Flowing	11-19-75	Flowing
28	10-16-75	Flowing	11-19-75	Flowing
29	10-16-75	Flowing	11-19-75	Flowing
30	10-13-75	Flowing	11-18-75	Flowing
31	10-13-75	Flowing	11-18-75	Flowing
32	10-13-75	Flowing	11-18-75	Flowing
33	10-15-75	Flowing	11-20-75	Flowing(Slush)
34	10-15-75	Flowing	11-20-75	Flowing(Slush)
35	10-15-75	Flowing	11-20-75	Flowing(Slush)

Table 2.4-3. Water and sediment chemistry, Analytical Laboratory Methodology. RBOSP Aquatic Baseline Studies.

Parameter	Measurement Methodology[1]	Detection Limit (ppm)[2]	Sample Preservation
	WATER CHEMISTRY		
Alkalinity, total	Colorimetric	2	None required
Ammonia nitrogen	Electrode	0.10	$HgCl_2$
Calcium, dissolved	Atomic absorption	0.02	None required
Chloride, dissolved	Potentiometric	0.4	None required
Hardness, total	EDTA Titration	2	None required
Magnesium, dissolved	Atomic absorption	0.005	HCl
Kjeldahl nitrogen	Kjeldahl digestion	0.10	$HgCl_2$
Nitrate, dissolved	Brucine	0.2	$HgCl_2$
Nitrite, dissolved	Diazotization	0.01	$HgCl_2$
Phosphate, ortho (dissolved)	Ammonium molybdate - potassium antimonyl tartrate	0.01	$HgCl_2$
Phosphate, total	Same as orthophosphate	0.01	$HgCl_2$
Potassium, dissolved	Atomic absorption	0.1	HCl
Silica, dissolved	Molybdosilicate	0.005	HCl
Sodium, dissolved	Atomic absorption	0.005	HCl
Sulfate, dissolved	Gravimetric	3	Refrigeration
Carbon, dissolved organic	Beckman TOC Analyzer	2	HCl
Carbon, total organic	Beckman TOC Analyzer	2	HCl
Solids, suspended	Filtration	1	None required
Solids, total dissolved	Filtration and evaporation	1	None required

[1]Methods are those specified in the Federal Register, Vol. 38, No. 199, Oct. 16, 1973, except for use of specific ion electrode.

[2]For water samples, this detection limit is the minimum concentration which will be reported on natural and treated water samples (99.99% H_2O) with the indicated method and using a sample of definite size.

Table 2.4-3. (Continued)

Parameter	Measurement Methodology	Detection Limit (ppm)	Sample Preservation
	SEDIMENT CHEMISTRY[3]		
Arsenic	Extraction and Atomic absorption	1	Refrigeration
Aluminum	Extraction and Atomic absorption	10	Refrigeration
Herbicide	Gas Chromatography	100ppb	Refrigeration
Lead	Extraction and Atomic absorption	0.5	Refrigeration
Mercury	Extraction and Atomic absorption	0.02	Refrigeration
Nitrogen, total Kjeldahl	Kjeldahl digestion - Electrode	10	Refrigeration
Phosphate, total	Persulfate digestion	0.25	Refrigeration
Solids, total volatile	Filtration, evaporation volatilization	10	Refrigeration
Zinc	Extraction and Atomic absorption	0.5	Refrigeration

[3]Detection limits vary with sample size.

2.4.1.3 Results

During the October 1975 sampling period, a total of six sampling sites was dry; the dry sites included Stations 6, 10, 11, 15, 16, and 18. During the November - December 1975 period, Stations 6, 10 - 12, and 16 were dry or frozen.

A data summary for selected parameters for the Yellow Creek and White River stations is presented below.

October 1975

Parameter	Yellow Creek	White River
Specific conductance (µmhos)	2150 - 4000	685 - 2475
pH	8.3 - 8.7	8.0 - 8.3
Alkalinity,total ($CaCO_3$ mg/l)	759 - 1669	185 - 208
Chloride (mg/l)	35 - 129	28 - 32
Sulfate (mg/l)	162 - 311	43 - 144
Dissolved solids (mg/l)	2108 - 2634	427 - 495
Turbidity (JTU)	5 - 20	5 - 9
Dissolved oxygen (mg/l)	10.0 - 12.6	10.3 - 11.6
Temperature (^0C)	2 - 11	7 - 9

November - December 1975

Parameter	Yellow Creek	White River
Specific conductance (µmhos)	2220 - 4000	- 3400
pH	8.1 - 8.6	8.3 - 8.4
Alkalinity,total ($CaCO_3$ mg/l)	811 - 1811	187 - 228
Chloride (mg/l)	27 - 154	22 - 37
Sulfate (mg/l)	189 - 286	43 - 144
Dissolved solids (mg/l)	1991 - 2786	351 - 502
Turbidity (JTU)	15 - 98	3 - 26
Dissolved oxygen (mg/l)	7.4 - 9.6	12.0 - 13.8
Temperature (^0C)	0 - 0	0 - 3

The summaries of selected physical and chemical data from the two sampling periods were generally consistent and reflected conditions of the fall and early winter. The high extremes of conductivity in the White River occurred at Station 28 near the mouth of Yellow Creek. Other conductivity values in the White River were nearer to the minimum values presented in the preceding data summaries. The data are generally within the ranges observed during the initial year of aquatic baseline studies.

2.4.2 Phytoplankton

2.4.2.1 Objectives

No change in objectives has occurred since Progress Report 3 - Summary. See Section 2.4.2.1 of that report for specific objectives.

2.4.2.2 Methods

No change in methods has occurred since Progress Report 2 - Summary. See Section 2.4.2.2 of that report for specific methods used in phytoplankton studies.

2.4.2.3 Results

A total of 115 taxa was observed in samples collected during October, 1975. During the October 1975 sampling, the most abundant phytoplankton at the headwater stations included the diatoms Achnanthes minutissima and Navicula cryptocephala and unidentified flagellated and non-flagellated chlorophytes. At Tract Stations 7, 8, 9, 12, and 13 the most abundant taxa generally belonged to the Chrysophyta and they included Achnanthes minutissima, Achnanthes lanceolata, Chrysidiastrum ocellatum, Navicula cryptocephala, Navicula gregaria, Navicula pelliculosa, Nitzschia capitata, Nitzschia denticula, Nitzschia dissipata, Nitzschia frustulum, and Nitzschia palea. At Station 14, the most abundant taxa were the cryptophyte Cryptomonas erosa and the diatoms Synedra miniscula, Cyclotella meneghiniana, Synedra fomalica, and Synedra amphicephala. At Station 17, phytoplankton was particularly abundant. The most abundant taxa included the diatoms Navicula cryptocephala and Nitzschia frustulum, the cryptophyte Cryptomonas erosa, and unidentified taxa belonging to the Chlorophyta and Cyanophyta. In Yellow Creek, the most abundant taxa at Station 19 were Cryptomonas erosa, Nitzschia acicularis and an unidentified flagellated chlorophyte, whereas, at Stations 20 - 22, the most abundant taxa were primarily the diatoms Cyclotella meneghiniana, Achnanthes minutissima, Nitzschia holsatica, Nitzschia palea, and Thalassiosira fluviatilis. In the White River, the dominant taxa included the diatoms Epithemia sorex, Diatoma vulgare, Navicula cryptocephala, Navicula salinarum var. intermedia, Gomphonema ventricosum, and Nitzschia frustulum and unidentified flagellated and non-flagellated chlorophyte species. Phytoplankton abundance was generally lowest in the White River during the October 1975 sampling.

During the November - December 1975 sampling period, the most abundant algal taxa in the phytoplankton at the headwater stations included the diatoms Achnanthes minutissima and Navicula pelliculosa. At the tract stations, the dominant taxa were the diatoms Achnanthes minutissima, Navicula cryptocephala, Synedra amphicephala, Nitzschia

acicularis, and Nitzschia frustulum, and an unidentified chlorophyte. In Yellow Creek, the diatoms Nitzschia holsatica and Cyclotella meneghiniana were the dominant phytoplankton taxa, whereas Navicula viridula, Diatoma vulgare, and an unidentified chlorophyte were dominant in the White River.

2.4.3 Zooplankton

2.4.3.1 Objectives

No change in objectives has occurred since Progress Report 3 - Summary. See that report for specific objectives.

2.4.3.2 Methods

In accordance with the revised aquatic Scope-of-Work on April 2, 1975 zooplankton samples are taken with a small submersible pump at all stations. Other methods remain unchanged from Progress Report 2 - Summary. See that report for specific methods

2.4.3.3 A total of 72 taxa was observed in samples collected during October 1975. Centropyxis species, and ciliates dominated the Protozoa at all sections of the sampling area. The rotifer fauna at the headwater and the spring-brook stations on Tract C-a were generally composed of bdelloids. Contracted monogononts were the most common forms at the river stations. Rotifers, as in previous months, were much more diverse at Station 14 and the Yellow Creek stations than elsewhere, with Lepadella, Monostyla, Notholca and other littoral forms abundant. Crustacea occurring in October, 1975, were similar to those found in August 1975. In October Nauplii, Bryocamptus hiemalis and ostracods occurred at the headwater and spring-brook stations. Stations 14 and 19 - 22 exhibited a high diversity with several cyclopoids and cladocera abundant. Crustacea were rare in the White River.

2.4.4 Periphyton

2.4.4.1 Objectives

No change in objectives has occurred since Progress Report 2 - Summary. See that report for specific objectives.

2.4.4.2 No change in methods has occurred since Progress Report 2 - Summary. See Section 2.4.4.2 of Progress Report 2 and 3 - Summary for specific methods.

2.4.4.3 Results

Periphytic algal densities and the number of species were generally low at the headwater stations (particularly at Station 3) during

the October 1975 sampling. The most abundant species included the chrysophytes Bicoeca lacustris, Achnanthes minutissima, Gomphonema intricatum, Epithemia sorex, and Navicula pelliculosa and the blue-greens Lyngbya spp. At the tract stations, the periphyton algal densities were higher than those of the headwaters. The most abundant taxa were Achnanthes minutissima, Achnanthes lanceolata, Bicoeca lacustris, Navicula cryptocephala, and Gomphonema intricatum. In Yellow Creek, the diatom Achnanthes minutissima was the dominant periphytic algal species at Stations 20 - 22, whereas Nitzschia frustulum, Nitzschia palea, and Achnanthes minutissima were the dominant species at Station 19. In White River, the most abundant taxa included Epithemia sorex and several other diatom species and the blue-greens Lyngbya spp.

During the November - December 1975 sampling period, the most abundant periphytic algal taxa included the chrysophytes Achnanthes lanceolata, Bicoeca lacustris, Navicula cryptocephala, Gomphonema intricatum, and the blue-greens Lyngbya spp. At the tract stations, the dominant taxa were Achnanthes minutissima, Gomphonema intricatum, Navicula cryptocephala, and Synedra amphicephala. In Yellow Creek, the most abundant periphytic taxa included Achnanthes minutissima, Synedra amphicephala, Nitzschia frustulum, Nitzschia holsatica, and the blue-greens Lyngbya spp. and Calothrix spp. The diatoms Epithemia sorex, Nitzschia dissipata, Diatoma vulgare, and Gomphonema ventricosum were the dominant algal taxa in the White River periphyton during the November - December sampling.

2.4.5 Benthos

2.4.5.1 Objectives

No change in objectives has occurred since Progress Report 2 - Summary. See Section 2.4.5.1 of that report for specific objectives.

2.4.5.2 Methods

The methods reported in Section 2.4.5.2 of Summary Progress Reports 2 and 3 remain unchanged with the exception that the D-frame net was utlized at Station 25 during both the October and November - December 1975 samplings of the White River. See Section 2.4.5.2 of Summary Progress Reports 2 and 3 for specific methods used in benthos sampling and analysis.

2.4.5.3 Results

A total of 111 benthic taxa was observed during the October 1975 sampling. The taxa are listed in Table 2.4-4. During the October sampling, the most abundant taxa at Headwater Stations 1 - 4 included Oligochaeta, Baetidae, Plecoptera, Chironomidae, and Simuliidae. At

Table 2.4-4. Benthos (Macroinvertebrate) taxa observed during RBOSP Aquatic Baseline Studies, October 1975.

PLATYHELMINTHES
- Turbellaria
  - Tricladida

NEMATODA

MOLLUSCA
- Gastropoda
  - Basommatophora
    - Lymnaeidae
      - *Lymnaea* sp.
    - Physidae
      - *Physa* sp.
    - Planorbidae

ANNELIDA
- Hirundinea
  - Rhynchobdellida
    - Glossiphoniidae
      - *Helobdella stagnalis*
- Oligochaeta
  - Haplotaxida
    - Enchytraeidae
    - Tubificidae
      - *Limnodrilus claparedianus*
      - *Limnodrilus hoffmeisteri typical*
      - *Limnodrilus udekemianus*
      - *Rhyacodrilinae* sp.
      - Immatures with capilliform chaetae
      - Immatures without capilliform chaetae
    - Naididae
      - *Nais* sp.
      - *Nais behningi*
      - *Pristina* sp.

ARTHROPODA
- Arachnoidea
  - Acari
- Crustacea
  - Amphipoda
    - Talitridae
      - *Hyalella azteca*

Table 2.4-4. (Continued)

Insecta
- Collembola
- Ephemeroptera
  - Baetidae
    - *Baetis* sp.
    - *Callibaetis* sp.
    - *Dactylobaetis* sp.
  - Heptageniidae
    - *Epeorus* sp.
    - *Heptagenia* sp
    - *Rhithrogena* sp.
  - Leptophlebiidae
    - *Choroterpes* sp.
    - *Traverella albertana*
  - Ephemerellidae
    - *Ephemerella* sp.
  - Caenidae
    - *Caenis* sp.
  - Tricorythidae
    - *Tricorythodes* sp.
- Odonata
  - Zygoptera
    - Coenagrionidae
      - *Argia* sp.
  - Anisoptera
    - Gomphidae
      - *Ophiogomphus severus*
- Plecoptera
  - Systellognatha
    - Perlodidae
      - *Isogenoides* sp.
      - *Isogenus* sp.
      - *Isoperla* sp.
- Hemiptera
  - Corixidae
- Coleoptera
  - Dytiscidae
    - *Deronectes* sp.
    - *Laccophilus* sp.
  - Hydraenidae
    - *Ochthebius* sp.
  - Hydrophilidae
    - *Cymbiodyta* sp.
  - Elmidae
    - *Dubiraphia* sp.
    - *Dubiraphia giulianii*
    - *Microcylloepus* sp.

Table 2.4-4. (Continued)

- *Optioservus* sp.
- *Zaitzevia* sp.

Trichoptera
- Glossosomatidae
- Hydropsychidae
  - *Cheumatopsyche* sp.
  - *Hydropsyche* sp.
- Hydroptilidae
  - *Mayatrichia* sp.
- Limnephilidae
  - *Hesperophylax* sp.
- Leptoceridae
  - *Oecetis* sp.

Lepidoptera
- Pyralidae

Diptera
- Tipulidae
  - *Dicranota* sp.
  - *Pedicia* sp.
  - *Ormosia* sp.
  - *Limnophila* sp.
  - *Holorusia* sp.
- Psychodidae
  - *Pericoma* sp.
- Thaumaleidae
- Ceratopogonidae
- Chironomidae
  - Unidentified
- Tanypodinae
  - *Ablabesmyia* sp.
  - *Larsia* sp.
  - *Pentaneurini* sp.
  - *Psectrotanypus* sp.
  - *Thienemannimyia* group sp.
- Diamesinae
  - *Diamesa* sp.
  - *Monodiamesa* sp.
  - *Prodiamesa* sp.
  - *Odontomesa* sp.
- Podonominae
  - *Parachlus* sp.
- Orthocladiinae
  - *Acricotopus* sp.
  - *Chaetocladius* sp.
  - *Corynoneura* sp.
  - *Cricotopus cricotopus*
  - *Cricotopus cricotopus bicinctus*
  - *Cricotopus cricotopus trifascia*

Table 2.4-4. (Continued)

Diplocladius sp.
Limnophyes sp.
Eukieferiella sp.
Orthocladius euorthocladius
Orthocladius euorthocladius sp. 17
Orthocladius sp.
Parakiefferiella sp.
Paraphaenocladius sp.
Parametriocnemus sp.
Pseudosmittia sp.
Parorthocladius sp.
Thienemanniella sp.
Orthocladiinae sp. 2
Orthocladiinae sp. 5
Chironominae
Chironomini sp.
Chironomus sp. group 2
Paratendipes sp.
Paracladopelma sp.
Phaenopsectra phaenopsectra
Polypedilum sp.
Polypedilum tripodura group
Stictochironomus sp.
Tanytarsini sp.
Tanytarsus sp.
Cladotanytarsus sp.
Micropsectra sp.
Rheotanytarsus sp.
Simuliidae
Simulium sp.
Stratiomyidae
Euparyphus sp.
Stratiomys sp.
Tabanidae
Chrysops sp.
Tabanus sp.
Rhagionidae
Atherix variegata
Empididae
Clinocera sp.
Ephydridae
Anthomyiidae
Limnophora aequifrons
Limnophora discreta

Station 5, the most abundant benthic taxa were Oligochaeta, Hyalella azteca, Ceratopogonidae, Chironomidae, and Simuliidae. The most abundant taxa at the tract stations included Baetidae, Plecoptera, Chironomidae, and Simuliidae, whereas in Yellow Creek, the most abundant organisms were Oligochaeta, Ceratopogonidae, Chironomidae, and Simuliidae. In the White River, the dominant taxa were Oligochaeta, Chironomidae, Ephemerella sp., Hydropsyche sp., and Rhithrogena sp.

During the November - December 1975 sampling period, the most abundant benthic taxa at the headwater stations included Chironomidae, Plecoptera, Baetidae, and Nemoura sp. (at Station 1). At the tract stations, the most abundant taxa were Oligochaeta, Chironomidae, Baetidae, and Plecoptera (at Station 8). In Yellow Creek, the dominant taxa at Stations 20 - 22 included Oligochaeta, Chironomidae, and Simuliidae, whereas the most abundant organisms at Station 19 were Acar, Trichoptera, and Hyalella azteca. In the White River, Baetidae, Chironomidae, and Ephemerella sp. were the most abundant taxa during November - December 1975.

2.4.6 Sediment Chemistry

2.4.6.1 Objectives

The objectives of the sediment chemistry studies remain unchanged from Progress Report 2 - Summary. See that report for specific objectives.

2.4.6.2 Methods

With the exception of analysis for arsenic which consists of a digestion procedure (EPA, 1973) followed by colorimetric analysis according to APHA (1971), no change in methods has occurred since Progress Report 3 - Summary. See Sections 2.4.5.2 and 2.4.6.2 of Summary Progress Reports 2 and 3, respectively, for specific methods used for sediment chemistry studies.

2.4.6.3 Results

In the October 1975 samples, concentrations of the herbicides Tordon 22K and Silvex were always less than 0.02 µg/g in the sediments. A summary of results for selected parameters from the October and November - December 1975 sampling periods is presented below. With the exception of aluminum, concentrations of the selected parameters were similar in the two streams during both sampling periods.

October 1975

Parameter (µg/g)	White River	Yellow Creek
Aluminum	3,600 - 13,300	6,300 - 18,500
Arsenic	3 - 6	3 - 5
Lead	6 - 14	6 - 12
Zinc	25 - 63	26 - 79

November - December 1975

Parameter (µg/g)	White River	Yellow Creek
Aluminum	3,000 - 12,900	4,000 - 6,700
Arsenic	3 - 5	2 - 10
Lead	5 - 14	6 - 10
Zinc	28 - 63	27 - 65

2.4.7 Macrophytes

2.4.7.1 Objectives

No change in objectives has occurred since Progress Report 3 - Summary. See Section 2.4.7.1 of that report for specific objectives.

2.4.7.2 Methods

No change in methods has occurred since Progress Report 2 - Summary. See Section 2.4.7.2 of that report for specific methods.

2.4.7.3 Results

During the October 1975 sampling, aquatic macrophytes were observed at four stations, including Stations 2, 5, 14, and 19. At Station 2, American speedwell (Veronica americana) was found in very low densities. At Station 5, watercress (Rorippa nasturtium-aquaticum) was observed in rank abundance, while the density of shore crowfoot (Ranunculus cymbolaria) was scattered. Horned pondweed (Zannichellia palustris) was found in rank density at Station 14, whereas shore crowfoot was found in very low densities at Station 19.

During the November - December 1975 sampling period, aquatic macrophytes were observed at Station 2 only. At Station 2, the abundance of American speedwell was scattered; it occurred in two patches, one of which measured approximately 0.2 x 0.05 meters and the other approximately 0.2 x 0.03 meters.

2.4.8 Fish

2.4.8.1 Objectives

The objectives of fish studies remain the same as those stated in Section 2.4-8 of Progress Report 2 - Summary.

2.4.8.2 Methods

No change in methods has occurred since Progress Report 2 - Summary. See Section 2.4.8.2 of that report for specific methods employed in fish studies.

2.4.8.3 Results

During the October 1975 sampling, a total of 194 fish representing ten species was captured in the White River (no fish were found in Yellow Creek). The most abundant fish captured were the mottled sculpin and the speckled dace. Only two game fish, a brown trout and a channel catfish, were collected during the sampling. Table 2.4-5 includes a summary of fish data from October and November 1975.

A total of 56 fish representing six species was captured in the White River during November. Since Yellow Creek was covered with ice during the sampling, fishing efforts were limited to the White River. The most abundant fish captured during the period included speckled dace and flannelmouth sucker. The small number of fish caught in November undoubtedly reflects the winter conditions present during the sampling. No game fish were found during November sampling.

2.4.9 Springs and Seepages

2.4.9.1 Objectives

No change in objectives has occurred since Progress Report 3 - Summary. See Section 2.4.9.1 of Progress Report 3 for specific objectives.

2.4.9.2 Methods

No change in methods has occurred since Progress Report 3 - Summary. See Section 2.4.9.2 of that report for specific methods.

2.4.9.3 Results

Approximate locations of springs and seepages on or near Tract C-a are shown on Figure 2.4-2.

Table 2.4-5. List of fish species and numbers captured in the White River during RBOSP Aquatic Baseline Studies, October 1975 and November - December 1975.

Common Name	Scientific Name	Number Captured	
		October	Nov. - Dec.
Brown trout	Salmo trutta	1	
Mountain whitefish	Prosopium williamsoni	9	
Flannelmouth sucker	Catostomus latipinnis	4	14
Bluehead sucker	Catostomus discobolus	8	3
Bluehead x Flannelmouth sucker	Catostomus latipinnis x Catostomus discobolus	1	
Roundtail chub	Gila robusta	1	
Speckled dace	Rhinichthys osculus	70	19
Fathead minnow	Pimephales promelas	1	1
Channel catfish	Ictaluras punctatus	1	
Mottled sculpin	Cottus bairdi	98	9

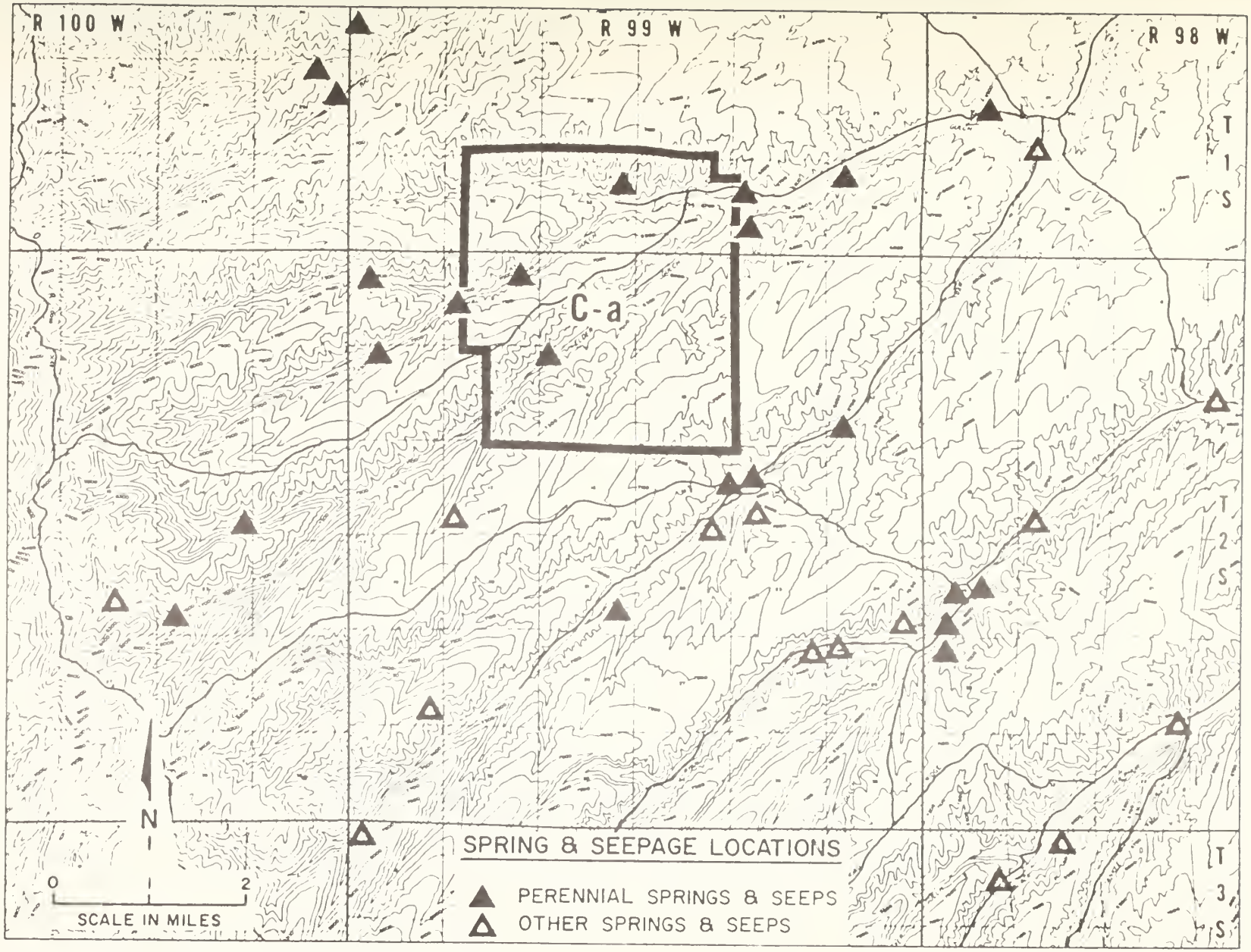


Figure 2.4-2. Spring and Seepage Locations

2.4.10 Hydrology

2.4.10.1 Objectives

The objective of this segment of the aquatic program is to measure the approximate stream velocities at each site at the time of sample collection to assist in characterizing the existing aquatic habitat.

2.4.10.2 Methods

Stream velocity is measured at each sampling site with Gurley flowmeters or an equivalent device.

2.4.10.3 Results

The approximate stream velocities during the October and November - December 1975 sampling periods are presented in Table 2.4-6.

2.4.11 Miscellaneous Studies

2.4.11.1 Objectives

No change in objectives has occurred since Progress Report 3 - Summary. See Section 2.4.11.1 of that report for specific objectives.

2.4.11.2 Methods

No change in methods has occurred since Progress Report 3 - Summary. See Section 2.4.11.2 of that report for parameters included in these studies. The frequency of collection of the various parameters included in these investigations and the list of parameters are presented in Table 2.4.7.

2.4.11.3 Results

Data from the October and December 1975 sampling periods are included in Table 2.4.8.

Table 2.4-6. Stream velocity, RBOSP Aquatic Baseline Studies, October 1975 and November - December, 1975. (Results are epxressed in feet per second, and, where appropriate are given for bank side and point of maximum flow.)

Station	Flow[3] (ft/sec) s	m	s	Station	Flow[3] (ft/sec) s	m	s
	October, 1975[1]				November - December, 1975[2]		
1		0.5		1		1.0	
2		0.9		2		1.0	
3		1.3		3		NM[4]	
4		1.1		4		1.7	
5		1.2		5		0.5	
7		1.7		7		0.8	
8		1.5		8		0.7	
9		1.6		9		1.1	
12		0.7		13		1.0	
13		1.9		14		0.3	
14		0.4		15		0.5	
17		NM[4]		17		0.5	
19		1.3		18		0.4	
20		1.3		19		0.9	
21		2.0		20		0.8	
22		2.0		21		1.5	
23	1.6;	3.6;	2.0	22		1.6	
24	1.5;	1.0		23	2.1;	3.2	
25	2.2;	1.6;	1.8	24	2.6;	2.9;	1.6
26		1.7;	0.8	25	3.3;	3.9;	2.6
27	0.2;	0.6;	1.0	26	1.5;	2.1;	3.3
28	0.7;	0.9;	0.1	27	0.7;	0.9;	0.1
29	4.5;	4.5;	1.8	28	0.9;	1.2;	0.7
30	2.7;	2.3;	1.8	29	2.1;	1.8;	2.1
31	3.1;	2.9;	2.7	30	3.3;	3.3;	1.7
32	1.1;	2.7;	3.1	31	3.1;	2.6;	3.3
33	0.8;	1.0;	0.6	32	1.6;	1.9;	3.1
34	1.7;	2.5		33	0.8;	2.2	
35	1.5;	4.5;	2.5	34	2.4;	2.2	
				35	0.9;	5.3	

[1]Stations 6, 10, 11, 15, 16 and 18 were dry at the time of sampling.
[2]Stations 6, 10 - 12 and 16 were dry at the time of sampling
[3]Measurements taken at bank sides (s) and point of maximum flow (m) where appropriate.
[4] NM = Not measurable

Table 2.4-7. List of parameters and sampling frequency for water quality investigations.

Semi-Monthly	Semi-Monthly[1]
Element or Compound	Element or Compound
Barium	Arsenic
Boron	Cadmium
Calcium	Lead
Chromium	Manganese
Cooper	Mercury
Fluoride	Phosphorus
Iron	Cyanide
Lithium	Sulfide
Magnesium	
Potassium	
Selenium	
Silicon	
Sodium	
Sulfate	
Zinc	
Ammonia	
Bicarbonate	
Carbonate	
Chloride	
Color	
Dissolved solids	
Kjeldahl nitrogen	
Nitrate	
Nitrite	
Odor	
Oil and Grease	
Turbidity	

[1] Subject to review

Table 2.4-7. (Continued)

Quarterly		
Organics	Radioactivity	Element or Compound
Total organic C • if < 10mg/l no additional analysis • if > 10mg/l then, Dissolved organic C Suspended organic C Phenols Sulfate Nitrogen Chemical oxygen demand Fecal coliform Pesticides	Gross Alpha > 4 picocuries/l analyze for RA 226 Gross Beta • if > 100 picocuries/l analyze for Th 230 and Natural Uranium	Complete Element Scan

Table 2.4-8. Water quality data, RBOSP Aquatic Baseline Studies, October 1975, November - December 1975, and February 1976. (Data are expressed in mg/l unless otherwise noted.)

PARAMETER	October 1975 STATION			
	REPLICATE			
	25		34	
	A	B	A	B
Arsenic (As), Diss	<0.01	<0.01	<0.01	<0.01
Barium (Ba), Diss	<0.1	<0.1	<0.1	<0.1
Boron (Bo), Diss	<0.5	<0.5	<0.5	<0.5
Cadmium (Cd), Diss	<0.01	<0.01	<0.01	<0.01
Carbon (C) Organic	<1	<1	<1	<1
Carbon (C) Organic Diss	3	<1	1	<1
Carbon (C) Organic Suspended	<1	<1	<1	<1
Chemical Oxygen Demand (O_2)	6	5	5	<5
Chromium (Cr) Total Diss	<0.03	<0.03	<0.03	<0.03
Copper (Cu), Diss	<0.02	<0.02	<0.02	<0.02
Cyanide (Cn), Total	<0.001	<0.001	<0.001	<0.001
Fluoride (F), Diss	0.23	0.21	0.16	0.21
Iron (Fe), Total Diss	0.02	0.02	0.02	0.02
Lead (Pb), Diss	<0.05	<0.05	<0.05	<0.05
Lithium (Li), Diss	<0.02	0.02	0.02	0.02
Manganese (Mn), Diss	<0.02	<0.02	<0.02	<0.02
Mercury (Hg), Diss (µg/l)	0.3	0.2	<0.2	<0.2
Nitrogen (N), Organic	0.25	0.21	0.16	0.15
Phosphorus (P), Total Diss	<0.01	<0.01	<0.01	<0.01
Phenolic compounds (Phenol)	0.011	0.007	0.007	0.006
Selenium (Se), Diss	<0.01	<0.01	<0.01	<0.01
Solvent extract (Oil)	0.06	0.03	0.03	0.01
Sulfate (S), Diss	144	141	138	138
Sulfide (S), Diss	<0.02	<0.02	<0.02	<0.02
Sulfur (S), Organic	1	9	8	4
Zinc (Zn), Diss	<0.02	<0.02	<0.02	<0.02

Diss = Dissolved

Table 2.4-8. (Continued)

November - December 1975

PARAMETER	STATION 25 A	STATION 25 B	STATION 34 A	STATION 34 B
Arsenic (As), Diss	0.04	0.04	< 0.01	< 0.01
Barium (Ba), Diss	< 0.1	< 0.1	< 0.1	< 0.1
Boron (Bo), Diss	< 0.5	< 0.5	< 0.5	< 0.5
Cadmium (Cd), Diss	< 0.01	< 0.01	< 0.01	< 0.01
Carbon (C), Organic				
Carbon (C), Organic Diss				
Carbon (C), Organic Suspended				
Chemical Oxygen Demand (O_2)				
Chromium (Cr), Total Diss	< 0.03	< 0.03	< 0.03	< 0.03
Copper (Cu), Diss	< 0.02	< 0.02	< 0.02	< 0.02
Cyanide (Cn), Total	< 0.001	< 0.001	< 0.001	< 0.001
Fluoride (F), Diss	0.28	0.27	0.23	0.23
Iron (Fe), Total Diss	0.03	0.04	0.04	0.03
Lead (Pb), Diss	< 0.05	< 0.05	< 0.05	< 0.05
Lithium (Li), Diss		0.04	0.04	0.04
Manganese (Mn), Diss	0.02	0.02	< 0.02	< 0.02
Mercury (Hg), Diss (µg/l)	0.3	0.3	< 0.2	< 0.2
Nitrogen (N), Organic				
Phosphorus (P), Total Diss	< 0.01	< 0.01	< 0.01	< 0.01
Phenolic compounds (Phenol)				
Selenium (Se), Diss	< 0.01	< 0.01	< 0.01	< 0.01
Solvent extract (Oil)	0.55	< 0.003	< 0.29	< 0.003
Sulfate (S), Diss	52	51	51	51
Sulfide (S), Diss	< 0.02	< 0.02	< 0.02	< 0.02
Sulfur (S), Organic				
Zinc (Zn), Diss	0.02	< 0.02	< 0.02	< 0.02

Literature Cited

American Public Health Association (APHA). 1971. Standard methods for examination of water and waste-water. 13th ed. APHA, New York. 874 pp.

Environmental Protection Agency. 1973. Sludge - sediment analysis. U.S. Environmental Protection Agency, Region IV, Surveillance & Analysis Branch.

2.5 Other Environmental Programs

2.5.1 Soils Survey and Productivity Assessment Studies

An inventory of soil types found on Tract C-a and adjacent areas and their physical and chemical characteristics and distribution is being conducted. Soils data are needed to understand the diverse relationships involved between soils, plants and wildlife and to design a revegetation program. Chemical data from overburden analyses are used to identify possibly toxic strata which may affect revegetation or lead to potential pollution of aquatic systems through leaching action on stockpiles or spent shale disposal sites. Physical and structural testing of soils and overburden are done to evaluate use potential for plant structures, disposal and storage sites, and reservoir construction.

A limited amount of information on general physical and chemical characteristics of soils and overburden of the oil shale area can be found in reports prepared by Campbell, et al. (1974) and Fox (1974). A general soils map (compiled at a scale of 1:250,000) of the oil shale area in Colorado was prepared by Campbell, et al. (1974). This general soils map includes Rio Blanco, Garfield, and Mesa counties.

2.5.1.1 Objectives

The objectives of the soil survey are to describe and map soil series, depths of the various horizons of soil, strike and dip of the soil, slope, vegetation cover, and erodibility. Soil maps, by providing information on the geographical extent and areal distribution of soils, erosion potential, sediment yield, runoff potential, site suitability, etc., can be used to make reliable predictions about soil behavior when subjected to various uses.

Studies of soil chemistry provide information on major and minor chemical elements in soils and provide a measure of the potential nutritive and toxic elements. Soil chemistry data are being correlated with phytosociological and plant distribution data to 1) ascertain relationships between plant response and soil chemical characteristics and 2) to determine if potentially toxic materials are present that may limit rehabilitation efforts and/or contribute potentially toxic materials (especially trace metals) to surface and groundwater systems.

Physical tests of soils aid in identifying soils and evaluating erosion potential and moisture-holding capacity of soils that may be used for revegetation.

2.5.1.2 Methods

A preliminary soils and vegetation survey of Tract C-a, 84 Mesa,

and adjacent areas was conducted in Spring 1975. Several soil pits were excavated concurrently with soil coring to identify soil series distribution. These data were used to produce a preliminary map of soil series distribution on Tract C-a and adjacent areas. More detailed information on the distribution of the various soil types, depths, zonation, number, width of horizons, and physical and chemical characteristics is being prepared and correlated with the type and success of vegetation in the area. Soil profiles of the area are being determined by field sampling from soil pits and by study of soil profiles exposed along road cuts and erosion faces.

Soil samples are taken at each of the 35 permanent vegetation sampling plots. In addition, five soil sampling sites are associated with each of the 11 major soil series.

Surface soil is collected from each soil horizon or, in the case of nondefinitive horizons, composite soil samples are collected at intervals from 0 to 10 cm, 10 to 50 cm, 50 to 100 cm, and 100 to 150 cm. In either case, a minimum of four soil samples per sample site are being collected.

Composite soil samples were taken using a 5-cm (2-in) diameter split spoon sampler at 45-cm (1.5-ft) increments down to 135 cm (4.5 ft). These samples, which supplement the surface soil sampling program, were taken from areas to be impacted by the mining operation. These additional sites include the on-site open pit mine areas and the proposed water control dam site area. These samples are currently undergoing chemical analysis.

Each of the soil samples are individually subjected to the laboratory analyses indicated below. Most procedures of chemical and physical analyses follow methods discussed by Black, et al. (1965).

Chemical Analysis

pH water
pH $CaCl_2$
Conductivity
Cation Exchange Capacity
Lime
Gypsum
Organic Matter
As
Cd
Cl
Cr
Co
F
Hg
Mo
NH_4
NO_3
Sb
Se
V

$NaHCO_3$ Extractable P
Total P

Water Soluble:
- B
- Ca
- K
- Mg
- Na
- SO_4

NH_4Ac Extractable:
- K
- Na
- Ni
- Pb

DTPA Extractable:
- Cu
- Fe
- Mn
- Zn

Background Radioactivity As:
- Uranium
- Equivalent Uranium
- Equivalent Thorium
- Potassium Radioactivity

Physical Analysis

Particle size distribution and classification - Bulk density
Soil moisture release curves - relationship between soil water potential and percent moisture.

2.5.1.3 Results

The preliminary soil map prepared by the SCS is currently undergoing further revisions. A general description of the 11 soil series (or associations) and rock outcrops encountered during surveying and mapping by the SCS are discussed in the RBOSP Annual Report, 1976.

Soil samples are currently being analyzed. Results will be submitted to the AOSS upon completion of the various programs (end of second quarter of 1976).

Literature Cited

Black, C.A., editor. 1965. Methods of soil analysis. Part I. Physical and mineralogical properties, including statistics of measurement and sampling. Part 2. Chemical and microbiological properties. American Society of Agronomy, Agronomy Series No. 9, Madison, WI. 2v.

Campbell, J.A., W.A. Berg, and R.D. Heil. 1974. Physical and chemical characteristics of overburden, spoils, and soils. In surface rehabilitation of land disturbances resulting from oil shale development, Colorado State University, Fort Collins, pp. 112-179.

Fox, Charles J. 1974. Soils impact analysis, Piceance Creek Basin, Rio Blanco and Garfield counties, Colorado. Thorne Ecological Institute ROSS-15, Boulder, CO. 35p.

Rio Blanco Oil Shale Project. 1976. Annual Report. Gulf Oil Corporation and Standard Oil of Indiana. Denver, CO. (In Press).

2.5.2 Archaeological Survey

2.5.2.1 Objectives

The objectives of the archaeology survey have been described in the DDP (RBOSP, 1976a) and previous quarterly progress reports (RBOSP, 1975, 1976b). One of the purposes of the detailed laboratory analysis is to determine if any sites are eligible for nomination to the National Register of Historic Places as set forth in the Federal Register 1966, and the Executive Order, 11593, 1971.

2.5.2.2 Methods

An extensive field survey and in-depth laboratory analysis were conducted. Methods used during the field survey and initial laboratory analyses were described in the DDP (RBOSP, 1976a) and previous quarterly progress reports (RBOSP 1975; 1976b). Further laboratory analysis has resulted in additional information on the cultural history of the area.

Refinement of site designations - Analysis of artifacts in the laboratory has lead to a refinement in site classifications. Three site classifications, Primary, Secondary and Tertiary, were originally used to describe locations yielding archaeological and historical material.

A quantitative system was designed in which numerical point values were assigned to various tool types, structures and pottery. The total number of points determined the site classification in the three grades.

Sites with more than 75 points were classified as Primary sites; those with 25 to 75 points, Secondary sites; and those with less than 25 points, Tertiary sites. Sites with the remains of structures such as wickiups were automatically classified as Primary sites.

Lithic Analysis - Additional study of lithic material collected during the survey included a site-by-site inspection of lithic materials. This inspection focused on the following:

- The amount of toolstone (inclusive of all stone artifacts) indigenous to the study area versus the amount of toolstone imported into the study area.
- The number of cortical waste flakes in comparison to the number of non-cortical flakes (a cortical flake retains some portion of the original weathered surface rock material, and is indicative of the first stages of chipped stone tool manufacture.)

- The relationship of waste flake material at a given site, to the chipped stone tools at the same site, including similar materials represented in both wastage and tools.

- The number of tools related to hunting activities versus the number of tools related to processing of vegetal foods.

Projectile point descriptions - Projectile points found during the RBOSP archaeological survey were examined in detail. This examination included measuring the specimens, defining the material of which they were made and classifying them into types on the basis of shape and size. A search of the literature was made to compare projectile points found during the survey to those found from other areas. The objective was to establish a relative date, geographic distribution and cultural affiliations.

Cluster Analysis - All the sites were mapped on a basemap derived from the 7-1/2 Minute Series USGS Topographic maps. Primary and Secondary sites were isolated and compared; in addition the number of Tertiary sites in a given cluster was assessed to give additional information. Cultural affiliations, when known, were also plotted, although this could not be determined for all sites.

The distributions of the various types of sites, their locations in relation to prominent topographic features, and types of artifacts recovered, and their cultural relationships were studied to determine cluster boundaries. Results of the cluster analysis revealed the presence of four areas, predominately related to topographic features (uplands) and drainage patterns. A discussion and description of these clusters appears later in this report.

Bibliographic search - A search of the literature was conducted to determine historical use of the area and to compare archaeological material from adjacent areas with material collected during the current survey, particularly for projectile point identification.

2.5.2.3 Results and Discussion

One hundred and ninety-seven sites containing archaeological or historical material were located during the archaeological survey. Primary or Secondary sites which occurred within the immediate vicinity of the study area are shown in Figure 2.5.2-1. Additional sites were also found along the Yellow Creek drainage, and to the north and east of the tract.

Lithic Analysis - Lithic tools were examined to explore the hypothesis that the region was utilized on a seasonal basis for the exploitation of game and vegetal resources. The analysis included identifying the amount of indigenous toolstone versus the amount of imported toolstone. Identification of chipped stone tool materials, which included chert, chalcedony, petrified wood and obsidian, indicate that most of this material was imported. No toolstone quarry sites

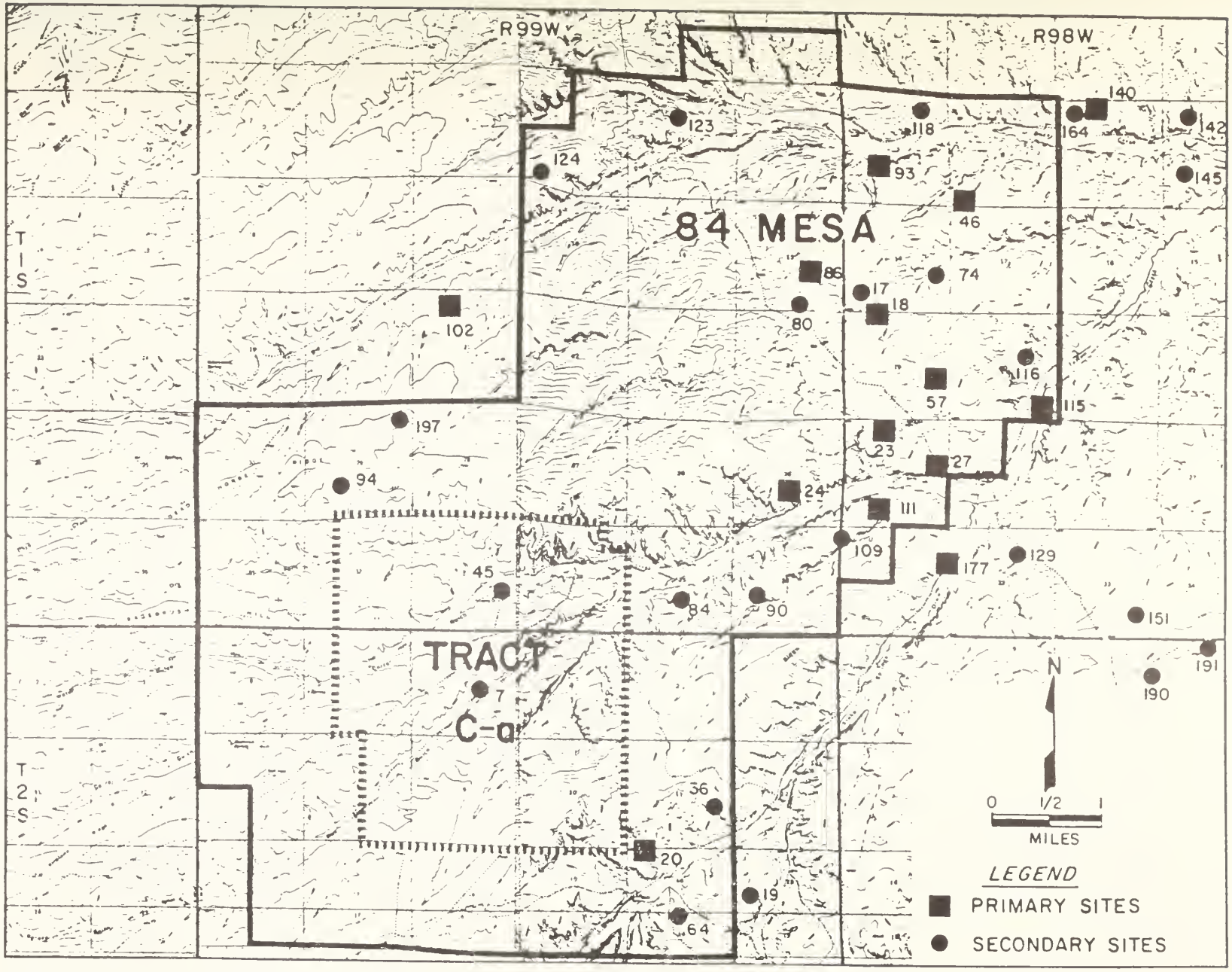


Figure 2.5.2-1 Locations of primary and secondary archaeological sites within the boundaries of Tract C-a, the 1-mile perimeter, and 84 Mesa.

were found in the area. However, groundstone tools were probably made of the local sandstones and shales.

The relationship of waste flake material at a given site to the amount of chipped stone material at the same site was examined to determine, within certain limitations, whether or not tools had been fashioned at the site location. Cortical flakes (flakes retaining a portion of the rock's original exterior or rind) may indicate manufacture at a particular location. In the initial production of tools, flakes are detached from the basic toolstone or core. The chips themselves can be used as tools or modified into other types of artifacts, or they can be discarded and the core shaped into a particular artifact. The transportation of large blocks of toolstone into remote areas is impractical. The presence of numerous small flakes and finished tools at primary sites suggest processing at a quarry site and then carrying the lighter blanks to be fashioned into tools as needed. These factors, plus the lack of good toolstone sources within the vicinity suggest the toolstone was imported and the tools were finished in the area.

The number of tools recovered from the study area which are associated with hunting was compared to the number associated with gathering activities. As a general rule, projectile points, knives and scrapers (chipped stone tools) are associated with hunting, while manos and metates (groundstone tools) are associated with gathering or farming. Most sites in the study area consist entirely of chipped stone tools and associated waste flakes. Groundstone tools were found only in limited numbers in isolated locations. Scrapers and knives were the most abundant type of tool recovered. The artifacts recovered from the study area indicate an exploitative system based on hunting, supplemented by gathering. The groundstone implements recovered from the study area were probably used to process wild seeds, rather than cultivated crops. Farming may have been practiced, but was probably not profitable. Stewart (1942) documented the use of manos and metates by the Ute for the grinding of pinyon nuts. Much of the study area is covered by pinyon-juniper stands, and pinyon nuts probably represent the single most abundant wild crop found in the area.

Hunting may have been centered around the seasonal movement of the White River mule deer herd, which moves into the area during the latter part of September and early October. Ripening of pinyon nuts also occurs during this period. Aboriginal use of the area probably corresponded with these two events.

Projectile point descriptions - During the RBOSP archaeological survey, a total of 143 projectile points and/or fragments was recovered. Of this total, 50 were identifiable and could be classified by type. Classifications were based primarily on similarities and differences (i.e., shape of blade, base and stem, presence or absence of notching,

size, and refinement). Each major type was subdivided to accommodate subtle differences (variations of base shapes and size). Projectile points were generally manufactured from quartzite, chalcedony, petrified wood, chert and obsidian. Four basic types were identified:

Triangular, unnotched (Type 1)

Triangular, side-notched (Type 2)

Triangular, corner-notched (Type 3)

Corner-notched (Type 4)

Type 1, subdivided into three groups, contains twenty-one identifiable projectile points. Some of these points may be associated with the Fremont Culture.

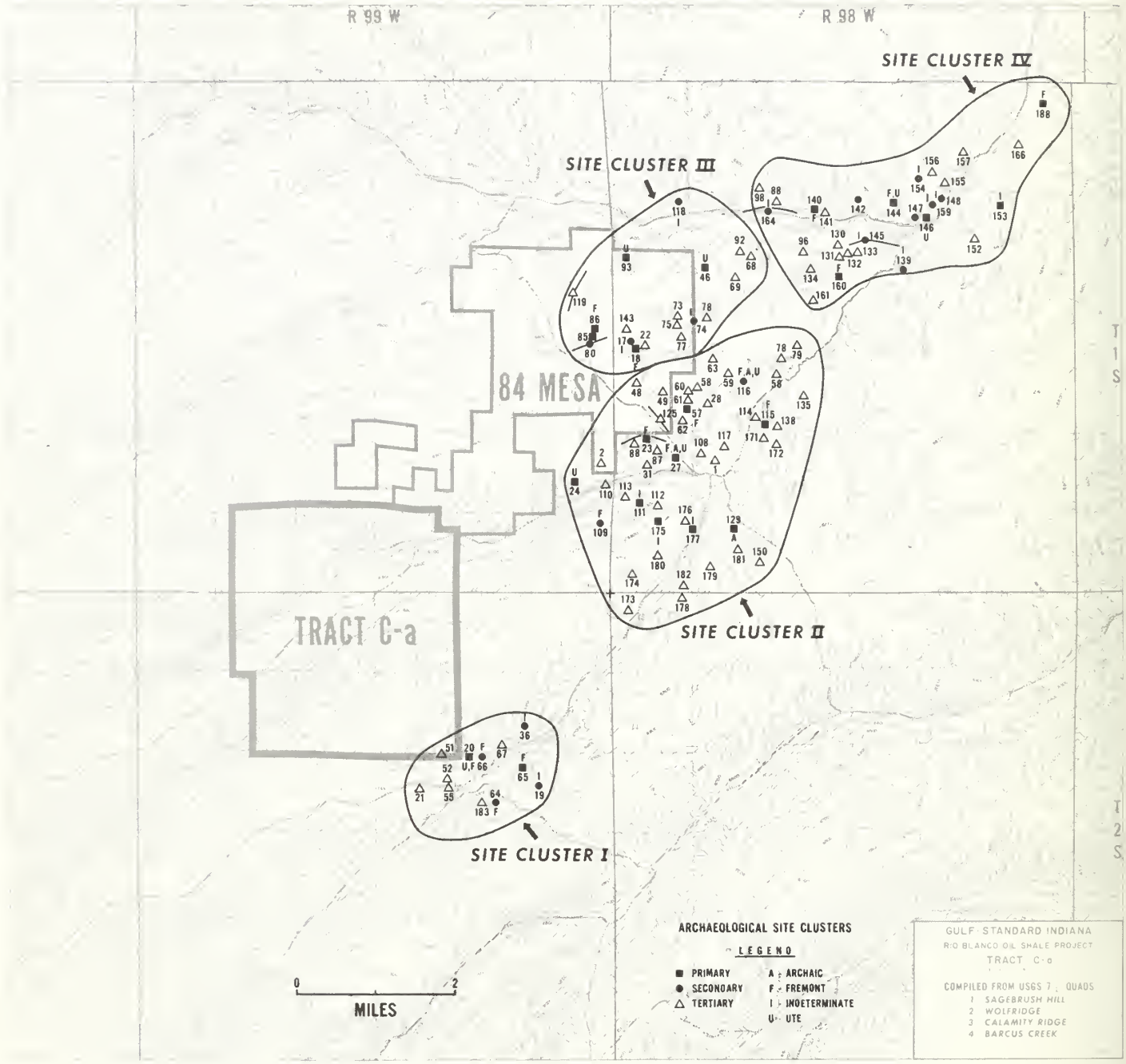
Nineteen Type 2 points, subdivided into 5 groups, were recovered and classified. They are associated with late Fremont or early Shoshonean cultures and are quite common throughout the Great Basin and Southwest.

Two Type 3 projectile points are dart points and are the oldest recovered on the survey. Only three were found. Dart points, generally associated with the use of the spear thrower or atl'art', are larger and heavier than later arrow points. Dates recorded for this type from other study areas are about 6400 B.C.

Seventeen Type 4 points were identified. In other areas, Type 4-A points date possibly to 6000 B.C., while the 4-C type dates from Fremont through the occupation of the area by Shoshonean peoples.

Cluster Analysis - Four site clusters were established on the basis of concentrations of sites related to topographic features, and proximity to watercourses (Figure 2.5.2-2). Cluster I occurs on upper Stake Springs Draw and encompasses approximately 583 ha (2.25 mi^2). It contains two Primary, four Secondary, and five Tertiary sites. One Primary site is of Fremont and Ute affiliation, and the other Primary site appears to be associated with the Fremont culture (Table 2.5.2-1). The Tertiary sites may represent work areas in the clusters.

Cluster II (Figure 2.5.2-2) occurs at the junction of Corral Gulch and Stake Springs Draw, and encompasses an area of approximately 2,000 ha (7.75 mi^2). Nine Primary, 2 Secondary, and 34 Tertiary sites occur within this cluster. Archaic, Fremont, and Ute cultural affiliations occur within this cluster (Table 2.5.2-2).



Archaeological Site Clusters

Figure 2.5.2 - 2

Table 2.5.2-1. Locations, numbers and descriptions of archaeological sites and materials found in Cluster I.

Field Number	Township	Range	Section	Tool Type					Site Classification	Cultural Affiliation
				Point	Knife	Scraper	Flakes	Other		
51	T2S,	R99W	S10, SE¼SE¼			1f			T	-
20	T2S,	R99W	S14, NW¼NW¼	2-4f	2f	3-4f	94	Hammerstone, drill(f) Wickiups	P	F(?)-U
21	T2S,	R99W	S15, SW¼NE¼		1		13		T	-
36	T2S,	R99W	S11, NE¼SE¼	1f	1	3f	20		S	I
52	T2S,	R99W	S15, SW¼NE¼		1H		5		T	-
55	T2S,	R99W	S15, SE¼NE¼	2f	1f		4	Toolstone	T	-
64	T2S,	R99W	S14, NW¼SE¼	2f	2f	1		Mano, fossil bones, core	S	F
65	T2S,	R99W	S14, NE¼NE¼	1				Hammerstone		
				3f	1	1f	107	Mano fragment	P	F
66	T2S,	R99W	S14, NE¼NW¼	1f		3f	25		S	F
67	T2S,	R99W	S11, SW¼SE¼			1f	10	Hammerstone	T	-
19	T2S,	R99W	S13, SW¼NW¼	2f	1					
					1f	1f	18	Hammerstone	S	I

f = Fragmentary tool, identifiable
H = Historic
P = Primary Site
S = Secondary Site
T = Tertiary Site
F = Fremont
I = Indeterminate
- = Cultural affiliation not attempted because of small number of artifacts

Table 2.5.2-2. Locations, numbers and descriptions of archaeological sites and materials found in Cluster II.

Field Number	Township	Range	Section	Tool Type					Site Classification	Cultural Affiliation
				Point	Knife	Scraper	Flakes	Other		
111	T1S,	R98W	S30, SE¼SW¼	2		6	103	Drill & mano fragments	P	I
113	T1S,	R98W	S30, SW¼SW¼	1f	1	2	5	Mano (f)	T	-
1	T1S,	R98W	S29, SE¼NW¼		2f	1 1f	7		T	-
2	T1S,	R99W	S25, SE¼NE¼	1	1f		3	Basin Metate (#2)	T	-
23	T1S,	R98W	S30, NW¼NE¼	3 7f	1 6f	15	178	Hammerstone, drill, 3 choppers	P	F
24	T1S,	R99W	S25, NW¼SE¼	1f		4f	97	Mano fragments	P	U
26	T1S,	R98W	S20, NW¼SW¼	1	2f	2f	1		T	-
27	T1S,	R98W	S30, SE¼NE¼	1 11f	9	16	177	Potsherds, drill F, cores, blades, manos	P	U
31	T1S,	R98W	S30, SE¼NW¼	2	1				T	-
48	T1S,	R98W	S19, SE¼NW¼	1			2		T	-
49	T1S,	R98W	S19, NW¼SE¼	1f			3		T	-
57	T1S,	R98W	S19, NE¼SE¼	2f	3	5	63	Drill (f), pottery	P	F
58	T1S,	R98W	S20, SW¼NW¼				3	1 potsherd	T	-
59	T1S,	R98W	S20, SE¼NW¼					Mano fragment	T	-
60	T1S,	R98W	S19, NE¼SE¼					Mano fragment	T	-
61	T1S,	R98W	S19, NE¼SE¼					Mano	T	-
62	T1S,	R98W	S19, SE¼SE¼			1f	2		T	-
63	T1S,	R98W	S20, NE¼NW¼				2		T	-
87	T1S,	R98W	S30, NW¼NE¼	1f			36	Toolstone	T	-
88	T1S,	R98W	S30, NW¼NW¼		1f	2		Mano	T	-
106	T1S,	R98W	S29, SW¼NW¼			1f	1		T	-

Table 2.5.2-2 (Continued)

Field Number	Township	Range	Section	Tool Type					Site Classification	Cultural Affiliation
				Point	Knife	Scraper	Flakes	Other		
110	T1S,	R99W	S25, NE¼SE¼			1			T	-
112	T1S,	R98W	S30, SW¼SE¼				2		T	-
114	T1S,	R98W	S20, SE¼SE¼				6		T	-
115	T1S,	R98W	S20, SE¼SE¼	1f	1	6	135	Bone, mano tool-stone, pottery	P	F
116	T1S,	R98W	S20, SW¼NE¼	2		1	13	Mano, toolstone	S	A-F-U
117	T1S,	R98W	S29, NE¼NW¼		2	2	9	Mano fragment	T	-
125	T1S,	R98W	S19, SW¼SE¼			1	8		T	-
109	T1S,	R99W	S36, NE¼NE¼	1	1	2	82	Mano	S	F
78	T1S,	R98W	S21, NW¼NW¼	1f		1f	5		T	-
79	T1S,	R98W	S16, SE¼SW¼			1f			T	-
129	T1S,	R98W	S32, NW¼NE¼	5f	1f	3f	88		P	A
135	T1S,	R98W	S21, NE¼SW¼				1		T	-
138	T1S,	R98W	S21, SW¼SW¼	1f	1f		2	Mano fragment	T	-
150	T1S,	R98W	S32, NE¼SE¼			1f	6		T	-
171	T1S,	R98W	S29, NE¼NE¼				3		T	-
172	T1S,	R98W	S28, NW¼NW¼				3		T	-
173	T2S,	R98W	S 6, NW¼NW¼			1,2f	5		T	-
174	T1S,	R98W	S31, SW¼				8		T	-
175	T1S,	R98W	S31, NW¼NE¼	3f	1f	2f	34	Mano, mano fragment, 5 tool fragments	P	
177	T1S,	R98W	S32, NW¼NW¼	4f	2f	2	74	Core tool	P	
178	T2S,	R98W	S 6, NE¼NE¼	1f		1			T	-
179	T1S,	R98W	S32, NW¼SW¼	1f			3	Tool fragment	T	-
180	T1S,	R98W	S31, NW¼SE¼	1f			2	Tool fragment	T	-
181	T1S,	R98W	S32, SW¼NE¼		2f		11	Tool fragment	T	-

Table 2.5.2-2 (Continued)

f = Fragmentary tool, identifiable
P = Primary Site
S = Secondary Site
T = Tertiary Site
F = Fremont
A = Archaic
I = Indeterminate
- = Cultural affiliation not attempted because of small number of artifacts

Cluster III (Figure 2.5.2-2) is located south of Duck Creek and covers about 980 ha (3.5 mi^2). It contains 5 Primary, 4 Secondary, and 10 Tertiary sites. Cultural affiliations include Fremont and Ute (Table 2.5.2-3).

Cluster IV (Figure 2.5.2-2) is located at the confluence of Duck and Yellow Creeks, and encompasses about 1,360 ha (5.25 mi^2). It contains 6 Primary sites, 8 Secondary sites, and 14 Tertiary sites. Ute and Fremont cultural affiliations occur within the cluster (Table 2.5.2-4).

In general, clusters appear to be located on uplands adjacent to watercourses and probably represent seasonal campsites. Lower-lying areas apparently were not used as camping areas, since concentrations of artifacts do not occur in these areas. Site clusters reflect a temporal span of occupation, which probably began as early as 9,000 B.P. Site clusters I, III, and IV exhibit Fremont occupation, which may have begun around 400 to 800 A.D.; Ute occupation, from ? to 1881 A.D.; and present day Anglo use (hunters and stockmen). Cluster II represents a temporal span from 9,000 B.P. through Fremont (136 A.D.) and Anglo (present) and is probably more archaeologically important than the other clusters. The large number of sites within this cluster, the types of projectile points found there, and the longer period of use represented by the artifacts indicate that further study of this area may be warranted.

Bibliographic search - An extensive review of the literature was presented in the DDP (RBOSP, 1976a) and previous quarterly reports (RBOSP, 1976b). C. Jennings (1974) conducted a surface survey in the Piceance Creek Basin in 1973. As a result of his findings, four sites in the vicinity of Tract C-a have been nominated to the National Register of Historic Places (C. Jennings, 1974). These sites include two locations on Tract C-a, and two locations several miles to the east of the tract.

In addition to Jennings' findings, a wickiup village containing the remains of 13 wickiups located on Duck Creek, several miles from the study area has been identified and placed on the National Register of Historic Places (Federal Register, November 20, 1975).

J. Jennings (1974) has postulated that there is convincing evidence that the climate and the resources in the West have remained almost unchanged since 10,000 B.P. and that man's history has been achieved essentially under current climatic conditions. This probably holds true for the Piceance Basin, with limited fluctuations in the flora and fauna of the area.

Surface collecting does not allow for absolute dating, but the types of projectile points found suggest that this area has been utilized for several thousand years, possibly beginning as early as 9,000 B.P.

Table 2.5.2-3. Locations, numbers and descriptions of archaeological sites and materials found in Cluster III.

Field Number	Township	Range	Section	Tool Type					Site Classification	Cultural Affiliation
				Point	Knife	Scraper	Flakes	Other		
17	T1S,	R98W	S18, SE¼SW¼	1f	3f	3f	6		S	I
22	T1S,	R98W	S18, SE¼SW¼				9		T	-
46	T1S,	R98W	S 8, SW¼SW¼	1f	1f		15	1 historic knife, hammerstone, 5 mano fragments, chopper, core, trade beads, wickiup structure	P	U
68	T1S,	R98W	S 8, SW¼SE¼		1	2f	9		T	-
69	T1S,	R98W	S17, NW¼NE¼				1		T	-
73	T1S,	R98W	S18, NE¼SE¼	1f			2	Mano	T	-
74	T1S,	R98W	S18, NE¼SE¼	1f		3	7	2 mano fragments, chopper	S	I
75	T1S,	R98W	S18, NE¼SE¼				3		T	-
76	T1S,	R98W	S17, NW¼SW¼			1f			T	-
77	T1S,	R98W	S18, SE¼SE¼					Toolstone	T	-
80	T1S,	R99W	S13, SW¼SE¼	1f	1f	4	25	Mano fragment, toolstone	S	I
85	T1S,	R99W	S13, SW¼SE¼		3f	4f	99		P	I
86	T1S,	R99W	S13, NE¼SE¼	1f	3f 4	1 2f	71	Toolstone, pottery	P	F
92	T1S,	R98W	S 8, NW¼SE¼			1	2		T	-
93	T1S,	R98W	S 7, SW¼SW¼					Wickiup structure, toolstone	P	U
118	T1S,	R98W	S 7, NE¼NE¼		4f	1f	25	1 mano fragment	S	I
119	T1S,	R99W	S13, SW¼NE¼	1f			11	Toolstone	T	-
143	T1S,	R98W	S18, NW¼SW¼			1f	1		T	-
18	T1S,	R98W	S18, SE¼SW¼	1 2f	1f	1f	104	Chopper (f)	P	F(?)

Table 2.5.2-3 (Continued)

f = Fragmentary tool, identifiable
P = Primary Site
S = Secondary Site
T = Tertiary Site
F = Fremont
U = Historic Ute
I = Indeterminate
- = Cultural affiliation not attempted because of small number of artifacts

Table 2.5.2-4. Locations, numbers and descriptions of archaeological sites and materials found in Cluster IV.

Field Number	Township Range Section	Tool Type					Site Classification	Cultural Affiliation
		Point	Knife	Scraper	Flakes	Other		
96	T1S,R98W S 9,NE¼SW¼					Mano fragment	T	-
98	T1S,R98W S 5,SE¼SE¼				1	Maul	T	-
130	T1S,R98W S 9,NE¼SE¼					1 mano in two fragments	T	-
131	T1S,R98W S 9,SE¼SE¼					1 mano fragment	T	-
132	T1S,R98W S 9,SE¼SE¼		1f	1f	14		T	-
133	T1S,R98W S10,SW¼SW¼					Mano fragment	T	-
134	T1S,R98W S 9,SE¼SW¼				5		T	-
139	T1S,R98W S10,SW¼SE¼		1f	1	49		S	I
140	T1S,R98W S 9,NE¼NW¼	3f	3f	4 1f	90	Drill, 5 tool fragments, mano, 4 mano fragments, toolstone, wickiups	P	F
141	T1S,R98W S 9,NW¼NE¼	1f	1f	2	7		T	-
142	T1S,R98W S10,NW¼NW¼			1	1	3 potsherds, core, hammerstone, mano, 10 mano fragments	S	
144	T1S,R98W S10,NW¼NE¼	1f	1f	3f	28	Mano fragment, wickiup	P	U-F
145	T1S,R98W S10,NW¼SW¼	1f		5f	14		S	I
146	T1S,R98W S10,SE¼NE¼	1f	1f	1	35	Chopper, 3 mano fragments, 2 wickiups, 13 small blue trade beads, 2 small white trade beads, 1 blue bead	P	U
147	T1S,R98W S10,SE¼NE¼		1f	3 4f	22		S	

Table 2.5.2-4 (Continued)

Field Number	Township	Range	Section	Tool Type					Site Classification	Cultural Affiliation
				Point	Knife	Scraper	Flakes	Other		
148	T1S,	R98W	S11, NW¼NW¼	2f	2f		52	1 gray sandstone bead	S	
152	T1S,	R98W	S11, NW¼SE¼	1		1	13	Mano, hammerstone, 1 hammerstone fragment	T	-
153	T1S,	R98W	S11, NE¼NE¼	1f	4f	6	51	Mano fragment	P	
154	T1S,	R98W	S 2, SW¼SW¼	1 2f	1f	1 1f	89		S	
155	T1S,	R98W	S 2, SW¼SW¼				5		T	-
156	T1S,	R98W	S 2, SW¼SW¼				3	Mano fragment petrified bone	T	-
157	T1S,	R98W	S 2, NE¼SW¼				20	Petrified bone	T	-
159	T1S,	R98W	S11, NW¼NW¼			4 2f	9	Hammerstone, 2 mano fragments	S	
160	T1S,	R98W	S16, NE¼NE¼	3f	4f	1f	43	1 potsherd, 3 mano fragments	P	F
161	T1S,	R98W	S16, SW¼NE¼		1f		4		T	-
164	T1S,	R98W	S 8, NE¼NE¼ S 9, NW¼NW¼	2f	3f	1f	12	Hammerstone, 4 mano fragments, chopper	S	
166	T1S,	R98W	S 1, SW¼NW¼		1	1	10	Mano, hammerstone	T	-
186	T1S,	R98W	S 1, NW¼NE¼	3f	1f	4f	40	Hammerstone, mano fragment, 3 tool fragments	P	F

f = Fragmentary tool, identifiable
P = Primary Site
S = Secondary Site
T = Tertiary Site
F = Fremont

The single most abundant food resource in the Piceance Basin was probably the White River mule deer herd. The basin is currently used as winter range by this herd, one of the largest in North America (RBOSP, Terrestrial Ecological Investigations, 1976b). The deer herd moves into the area during October and remains there until spring. The herd moves out of the basin during the late spring and early summer into an upland range on the Flat Tops area in the upper reaches of the White River drainage. The Piceance Basin is not a prime present day elk range.

Forty-one species of grasses and grass-like plants grow in the area (RBOSP, Terrestrial Report, 1976b). The prehistoric diversity and abundance of wild grasses was probably similar to present day conditions. These grasses represent a potential food resource and were probably harvested when they were available.

Pinyon pine (Pinus edulus) (which individually seed about every five years) may also have been an important food source utilized by aboriginal peoples in the study area. Pinyon-pine seeds mature in late September or early October.

Marginal agriculture may have been practiced in the Piceance Basin. The growing season is 123 days long and the average annual precipitation is 30 to 44 cm (11.9 to 17.2 inches) per year. Current agricultural activity, except for small gardens at local ranches, is limited to hay meadows. The archaeological survey did not produce any evidence of aboriginal agriculture in the study area.

Evidence of agricultural activity in Northwestern Colorado begins with the Fremont period (Breternitz 1970). Distinctive traits associated with agricultural activity include small village sites, the manufacture and use of pottery, and corn growing. Agricultural utilization of the Piceance Basin by the Fremont people, however, cannot be demonstrated. Fremont structures and granaries, an indication of permanent habitation and a relatively secure economy based on agriculture, were not found in the Piceance Basin. To the contrary, Lithic tools of the Fremont period indicate that hunting and gathering were important on a seasonal basis.

Six sites contained Historic Ute structures and trade beads. They are 20, 46, 93, 140, 144, and 146. The remains of a Ute wickiup from the study area (A) and a similar Ute wickiup (Denver Public Library) near Cedaredge, Colorado (B) are shown in Figure 2.5.2-3. Figure 2.5.2-4 is a photograph of an historic Ute wickiup structure near Whiterocks, Utah.

Trade beads found on the site were analyzed by Richard Conn, curator of the Denver Art Museum. He tentatively dated one white bead, from site 46, as being from the late 18th century. The blue seed beads found on site 146, are probably from the early 19th century. However, a positive temporal correlation between the beads and the Ute structures is nebulous due to the limited number of samples.

A. Remains of wickiup on site 46 south of Duck Creek.

B. Remains of similar Ute wickiup found near Cedaredge, Colorado.

Figure 2.5.2 - 3

Figure 2.5.2-4 Historic Ute Wickiup Structure Near Whiterocks, Utah, 1909 (Smith: 1974)

There is no direct evidence of the origin of the Ute who occupied the Yampa and White River drainages. Conjecture from scanty archaeological evidence and Escalante's account is that the prehorse Ute resembled other foot Shoshoni groups. However, conclusions about the nature of the prehorse Ute groups and the territory they occupied is only speculative. The first Shoshonean techniques of seed-gathering, fishing, root-digging, and of hunting deer, rabbits and antelope all represent adaptations to a semi-arid environment. Few localities afforded an abundance of food resources and it was necessary for these people to move seasonally to the areas of seed plots or hunting grounds. The quest for food was carried out by individual families or by small groups of families. Cooperation between families occurred only in collective rabbit and antelope drives (Steward, 1974).

The Colorado Utes had horses by 1776 when Escalante traveled through the area. The economic base and socio-political organization was modified as an adaptation to mobility (Steward, 1974). The increased mobility and transportational value of the horse led to closer association between the villages and contributed to a loose band formation built upon personal allegiance to a leader. There was never any over-all Ute political organization. Individuals moved back and forth from one place to another staying with whatever leader offered the greatest hope (Steward, 1974).

By 1850, the Yampa Ute had displaced the Comanche and occupied the general area of the Grand, White and Yampa River drainages. Equestrian Yampa Utes roamed through Colorado, Wyoming and Utah, but wintered in South, Middle, and North Parks in Colorado. These large intermountain valleys were excellent spots for hunting bison.

After the bison had disappeared from the parks by the 1860's, only small groups of Ute wandered through the region, partly because of the difficulty of procuring enough food to support a large population.

The treaty of 1868 established the northern boundary of the Confederate Ute at about 40°10' latitude, 107° longitude on the east and the Colorado Territory boundaries on the west and south. The Ute apparently wandered further in the quest for food after the White River Agency was established (Steward, 1974).

In 1881, after the Meeker Massacre, the White River Utes were moved from Colorado to their present day location on the Uintah and Ouray Reservation in eastern Utah.

In the recent historic period, the Piceance Basin has been used as rangeland for the grazing of sheep and cattle. Although quite seasonal, the area is intensively hunted during the October deer season. The Piceance drainage and Parachute Creek area are known as some of the finest deer hunting areas in western Colorado.

Conclusions - The projectile point analysis and other archaeological evidence found during the survey establishes that man's utilization of the Piceance Basin began possibly as early as 9,000 B.P. Fremont occupied the area from 400 A.D. to 800 A.D. to about 1350 A.D.; the Ute, from ? to 1881; and the Anglos in historic times.

Data assembled to date and ethnographic reports support the supposition that aboriginal man used the Piceance Basin on a seasonal basis geared predominantly to hunting activities, probably associated with seasonal movements of the White River mule deer herd. The relatively small number of groundstone tools in relation to chipped stone tools found during the survey indicates that limited gathering and food processing activities were carried on, but were probably of secondary importance to hunting. Seasonal use of the area probably corresponded to the ripening of pinyon nuts and the movement of the deer herd into the area occurring during the later part of September and into October.

Four clusters of archaeological material have been identified in the study area. These clusters provide important information on the temporal span of occupation (the Fremont-Ute relationship and utilization of the area by the Ute) and should be considered for additional study before development of the area proceeds.

A final report on the archaeological significance of the area, including all information assembled during the field and laboratory studies, and recommendations for nomination of sites to the National Register of Historic Places, if any, will be submitted to State and Federal regulatory agencies during the seventh quarter of study. Data to date indicate that some recommendations may be made.

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2.5.3 Revegetation

The revegetation program for RBOSP Tract C-a is designed to investigate current revegetation technology and develop a plan to successfully reestablish a plant community on the processed oil shale disposal pile in accordance with the environmental stipulations as described in the Federal Register, Volume 39, Number 230, Part 3, Oil Shale Lease Environmental Stipulations. This revegetation plan will be developed as a result of extensive field experiments and laboratory studies designed to provide data pertinent to Tract C-a.

The location of the revegetation experimental plots is in the southeast corner of Tract C-a as shown in Figure 2.5.3-1, Progress Report 5 - Summary. The revegetation test sites were selected to represent opposing slope aspects at elevations between 7100 and 7200 ft with slopes approximating 3:1. Trials in each of the 2 subsequent years will utilize a single site on the slope having the most extreme drought conditions.

Several other revegetation studies are currently being conducted in the Piceance Creek Basin. These studies deal both with problems of revegetating processed oil shale and with selection of appropriate revegetation methods for vegetation types similar to those existing on Tract C-a. Results from these studies will be analyzed and incorporated into the overall revegetation plan to successfully reestablish a plant community on the processed oil shale disposal pile on Tract C-a.

2.5.3.1 Objectives

No changes in objectives have occurred since Progress Report 5 - Summary. See section 2.5.3.1 in Progress Report 5 - Summary for objectives of the revegetation studies.

2.5.3.2 Methods

A detailed description of methods utilized in the revegetation program is presented in Section 2.5.3.2 of Progress Report 4 - Summary. No changes have been implemented since this report was released except for the deletion of snowberry (Symphoricarpos oreophilus) from the list of plant species to be seeded on the revegetation plots.

2.5.3.3 Results

The RBOSP revegetation test plots were prepared and seeded

during the period of November 3-14, 1975. See Section 2.5.3.3, Progress Report 5 - Summary for a detailed account of the procedures involved.

Surface soils from the revegetation test plots were potted in December, 1975. Soil samples were spread over a sterile potting medium to a depth of 1.27 cm (1/2 in), seeded, watered and maintained at a minimum night temperature of 15.5°C (60°F). Seed germination has occurred and the emerged seedlings have been transplanted to separate containers. In addition, the six species of grasses planted in the revegetation test plots (see Table 2.5.3-1), Progress Report 4 - Summary) are also being grown in the greenhouse so that voucher specimens of each grass species at various vegetative stages will be available. These voucher specimens will aid in identification of the emerged seedlings on the revegetation plots in the spring of 1976.

Soil moisture determinations of soil samples collected prior to seedbed preparation were conducted and reported in Tables 2.5.3-3 and 2.5.3-4, Progress Report 5 - Summary. A more accurate accounting of soil moisture relationships will be gained as more seasonal soil moisture data are compiled during the course of the revegetation studies.

The earliest results of the on tract revegetation experiments will be collected in the spring of 1976. These results will be analyzed by methods discussed in detail in Section 2.5.3.3 of Progress Report 5 - Summary.

2.5.4 Toxicology

Toxicology studies are not a part of the environmental baseline studies. They were discussed in Section 9, Chapter 2 of the DDP.

2.5.5 Trace Metals

Determination of heavy metals concentrations in soils from the study area is being made as a part of the soils survey (Section 2.5.1). Analyses of soil samples taken earlier from the study area are currently underway. Results of these and other soil samples analyses will be available after the seventh quarter of study. When these data become available, additional trace metal analyses will be done on plants and animals, if the data indicate that they are advisable.

2.5.6 Visibility Studies

Joint visibility studies are discussed in Section 2.2.3.5b of this report.

2.5.7 Seismicity

The results of the seismicity study were presented in Progress Report 3 - Summary. No additional work has been done.

2.5.8 Paleontological Survey

Results of paleontological studies were reported in Progress Report 5 - Summary. No additional work was done during the winter quarter.

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